

# **COMPUTER NETWORKS AND INTERNET PROTOCOLS**

## **Application Layer – II (DNS)**

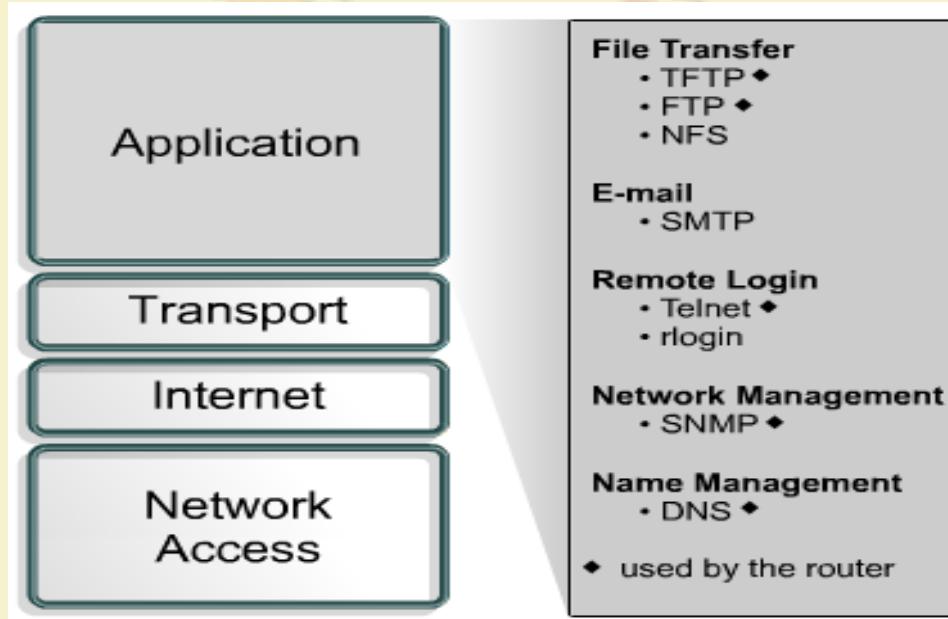
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COMPUTER SCIENCE AND ENGINEERING  
IIT KHARAGPUR

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# TCP/IP - Application Layer



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# Application Layer Examples

- Domain Name System (DNS)
- File Transfer Protocol (FTP)
- Hypertext Transfer Protocol (HTTP)
- Simple Mail Transport Protocol (SMTP)
- Simple Network Management Protocol (SNMP)
- Telnet
- ....



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# What is DNS?

- The global database system for Internet addressing, mail and other information.
  - Much easier to use and memorize.
- Concept of domains and sub-domains.
  - Domain management is distributed.
  - DNS servers translate domain names to IP addresses.



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# Top Level Domains

- com – Commercial
- org – Non-profit
- net – Network service provider
- gov – US govt.
- mil – military
- edu – Education
- au – Australian
- at – Austrian
- ca – Canadian
- dk – Dutch
- fr – French
- de – German
- in – Indian
- it – Italian
- jp – Japanese
- kr – Korean
- nz – New Zealand
- es – Spanish
- tw – Taiwanese
- uk – British or Irish
- us – U.S.

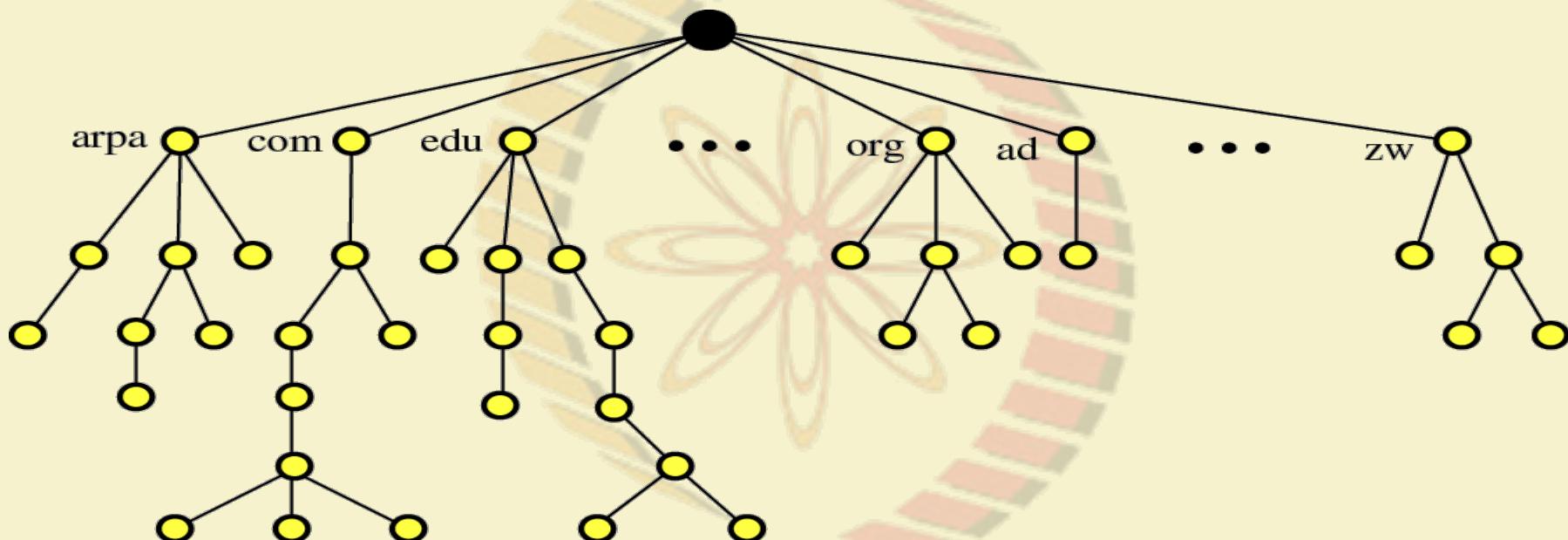


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# Domain Name Space

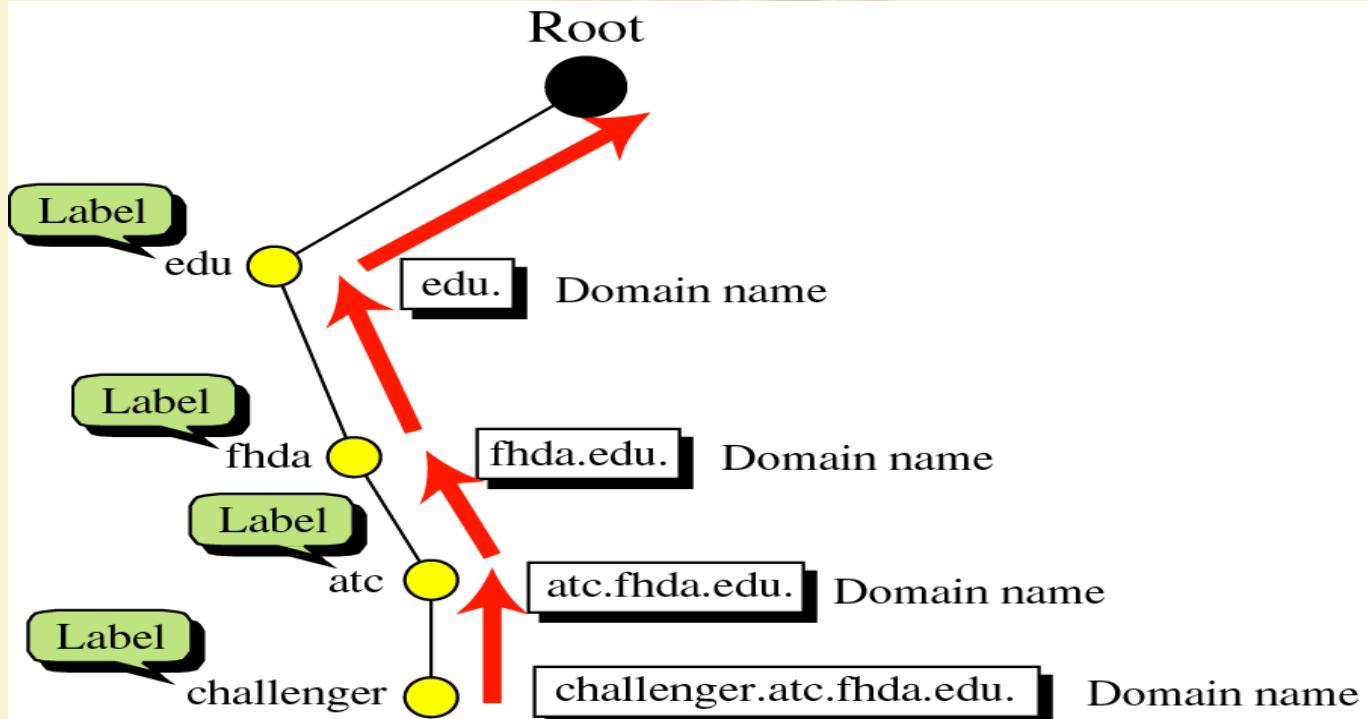


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# Domain Names and Labels

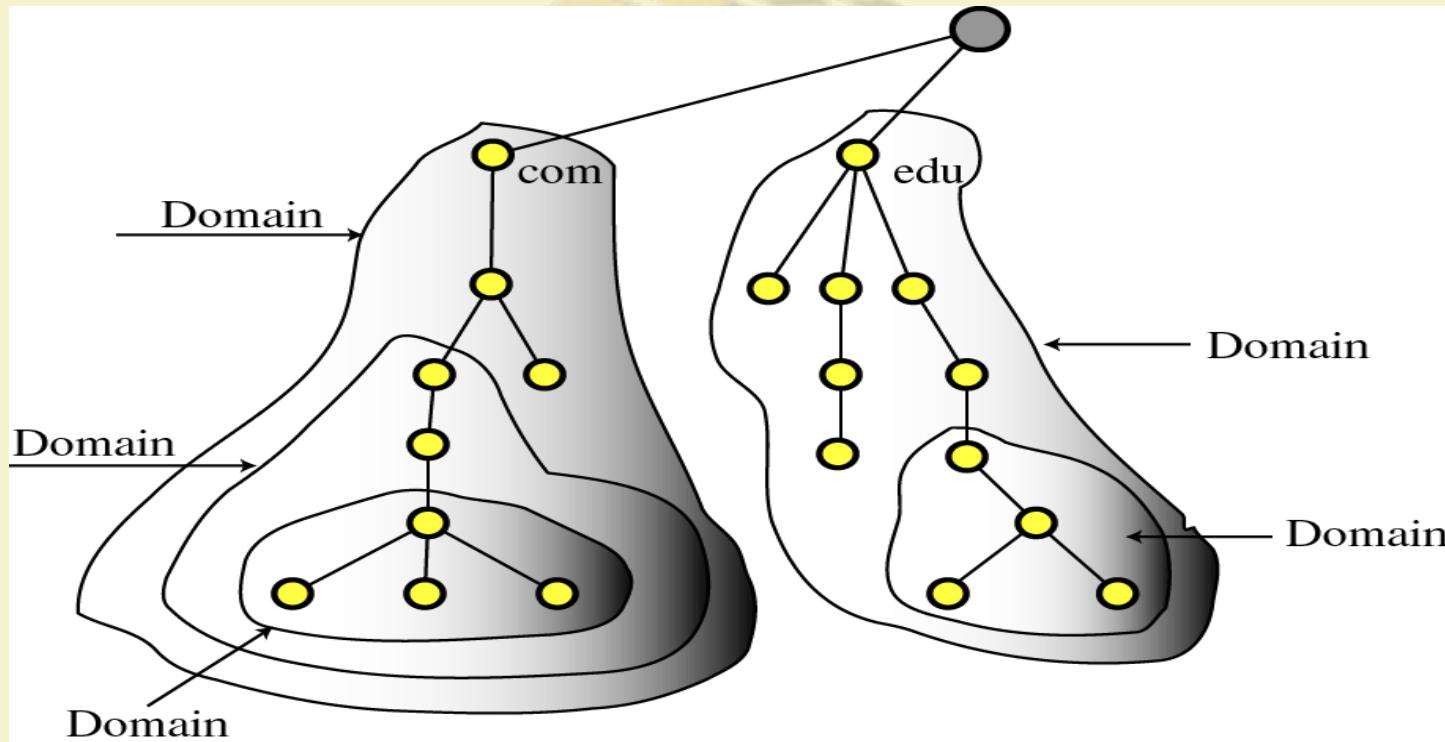


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# Domains



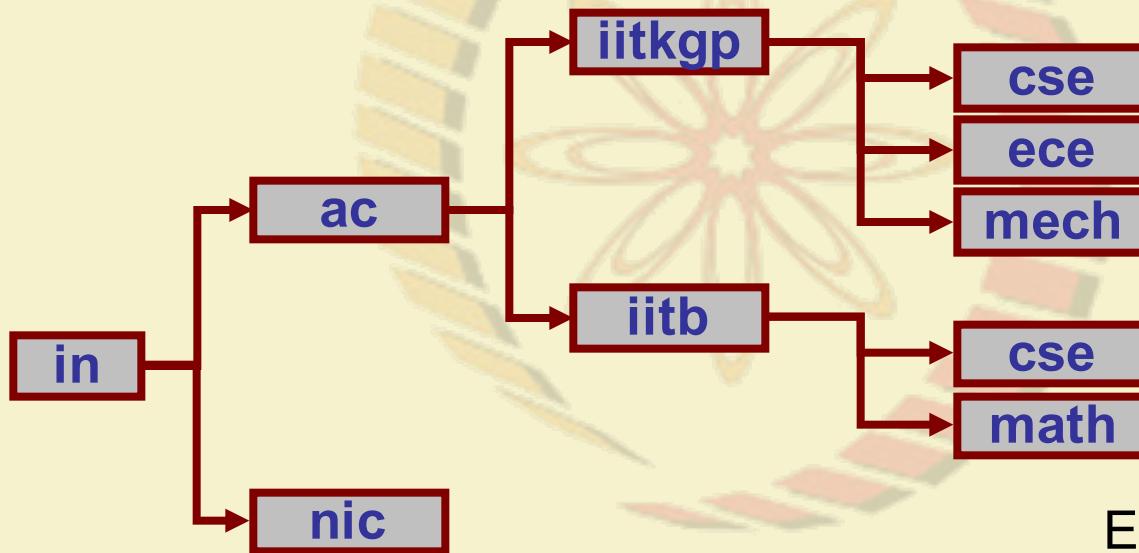
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# Domain Name Structure

- Domain names are arranged in a hierarchical tree-like structure.



Eg: cse.iitkgp.ac.in

# Fully qualified domain names (FQDNs)

- If a domain name ends in a dot it is assumed to be complete. This is called a *fully qualified domain name* (FQDN) or an absolute domain name.
- If a domain name does not end in a dot, it is incomplete and the DNS resolver may complete this by appending a suffix to the domain name. The rules for doing this are implementation-dependent and locally configurable.

# Generic TLDs

- The top-level names are called the generic top-level domains (gTLDs), and can be three characters or more in length.
- These names are registered with and maintained by the Internet Corporation for Assigned Names and Numbers (ICANN).

<http://www.icann.org>

# Generic TLDs (examples)

Domain name	Meaning
aero	The air transport industry
biz	Business use
cat	The Catalan culture
com	Commercial organizations
coop	Cooperatives
edu	Educational organizations
gov	U.S. governmental agencies
info	Informational sites
int	International organizations
jobs	Employment-related sites
mil	The U.S. military
mobi	Mobile devices sites
museum	Museums



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# Country Domains

- Top-level domains named for each of the ISO 3166 international 2-character country codes (from ae for the United Arab Emirates to zw for Zimbabwe). These are called the country domains or the geographical domains.
- Many countries have their own second-level domains underneath which parallel the generic top-level domains.

# Distribution of Name Space

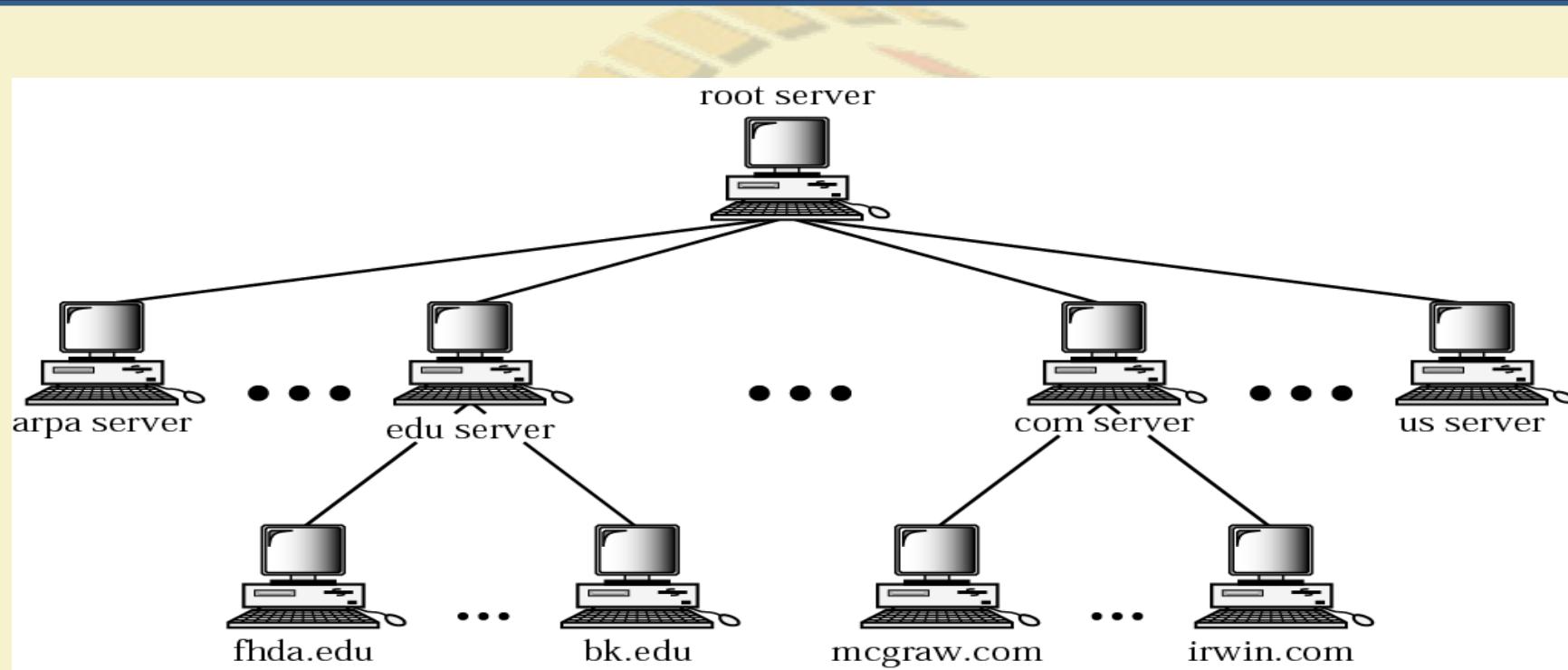


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# Hierarchy of Name Servers

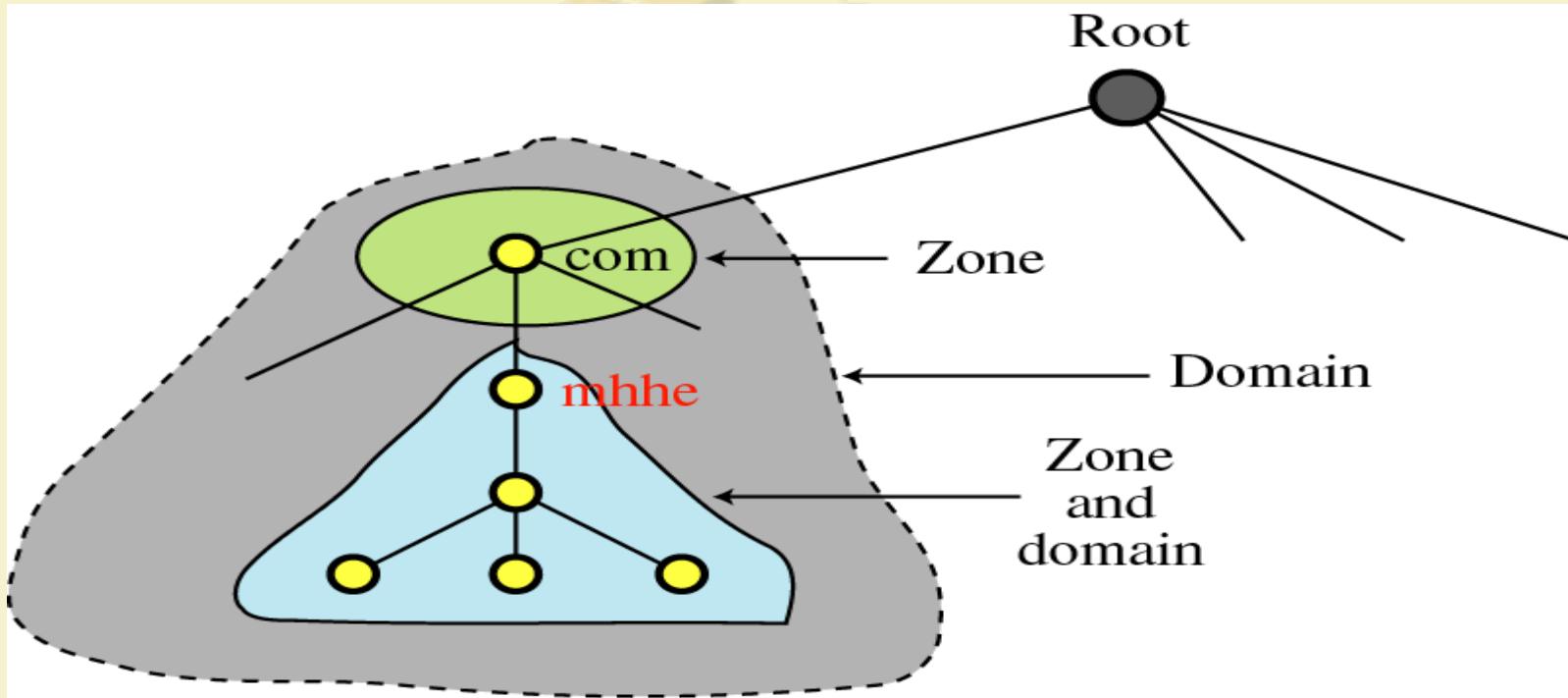


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# Zones and Domains



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# What is a Zone?

- Domains are broken into zones for which individual DNS servers are responsible.
  - A domain represents the entire set of names/machines that are contained under an organizational domain name.
  - A zone is a domain minus any sub-domains delegated to other DNS servers.



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# The Concept

- Each domain name is typically served by 2 or more DNS servers for redundancy.
  - Referred to as primary and secondary.
- Only one DNS server should be configured as primary for a zone.
  - Several secondary DNS servers possible.
  - The primary server contains master copy of the data for a zone.
  - Secondary servers get copies of this data through zone transfers.



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# Zone Transfer

- A primary server loads all information from the disk file.
- The secondary server loads all information from the primary server.
- When the primary downloads information from the secondary, it is called zone transfer.



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# DNS in the Internet

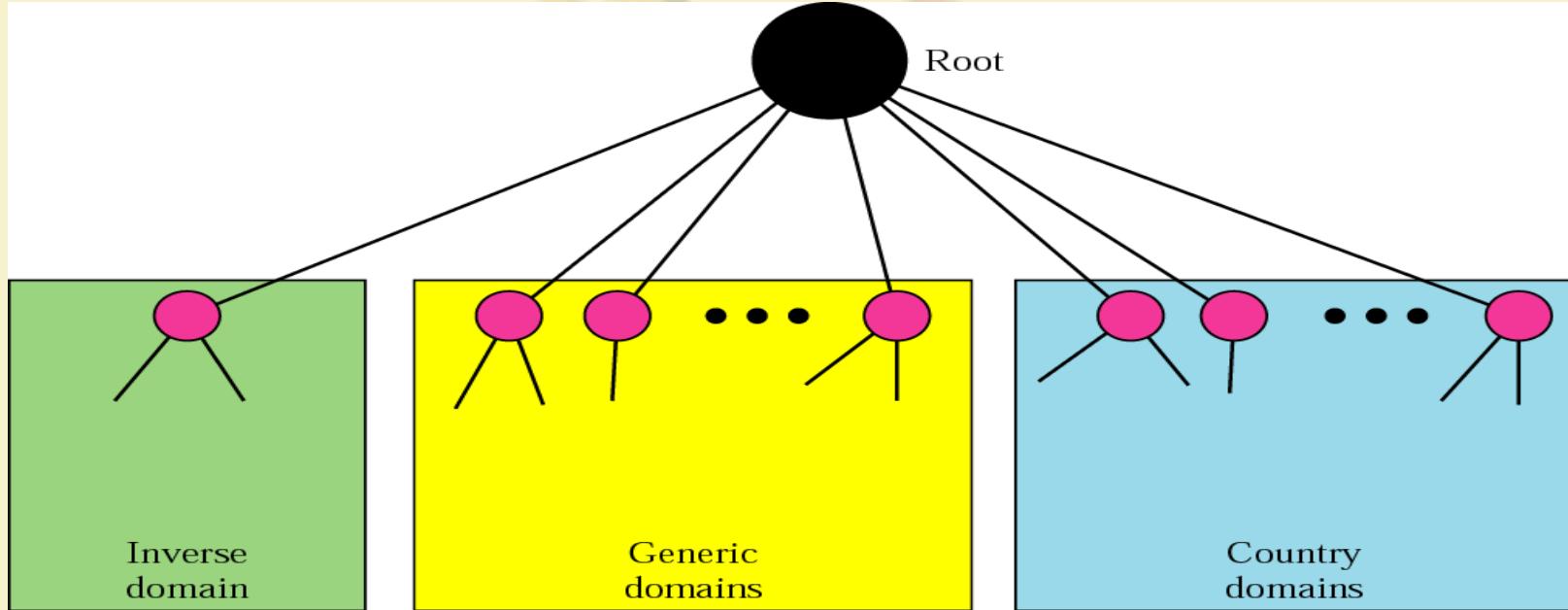


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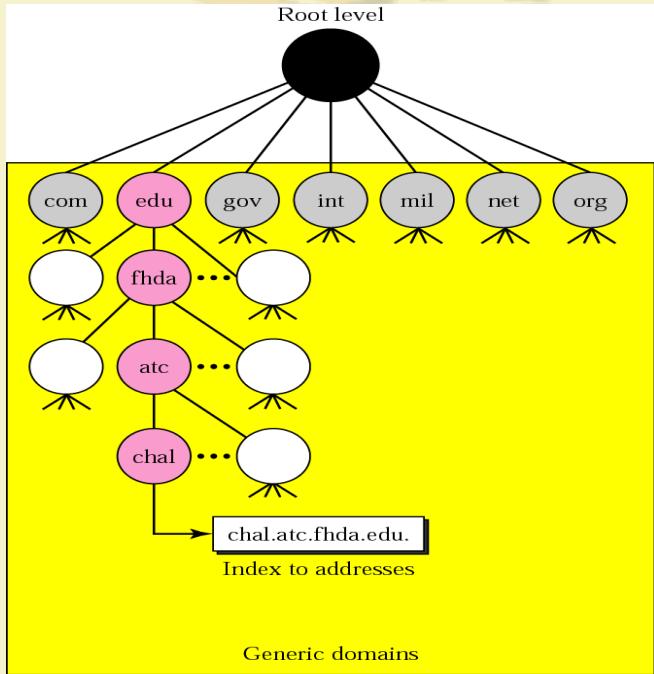


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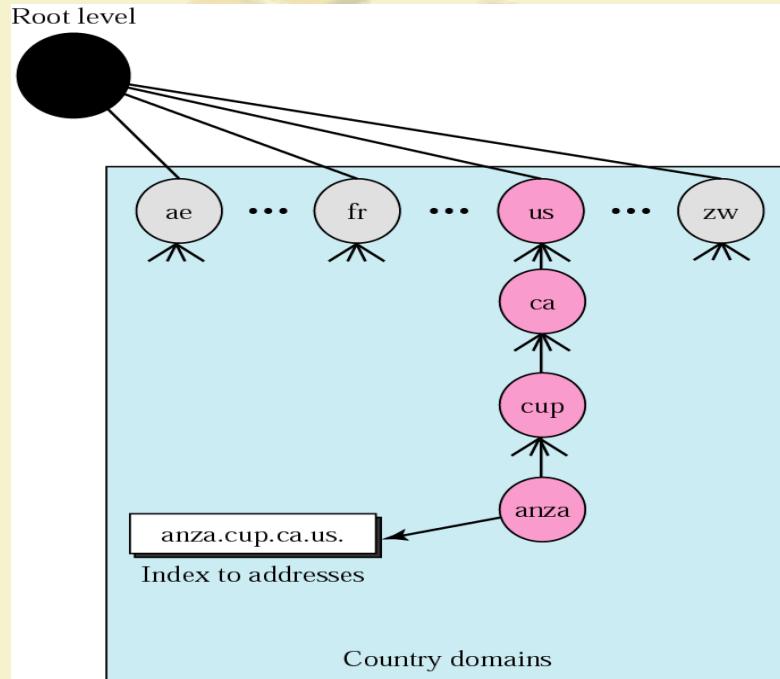
# DNS in the Internet



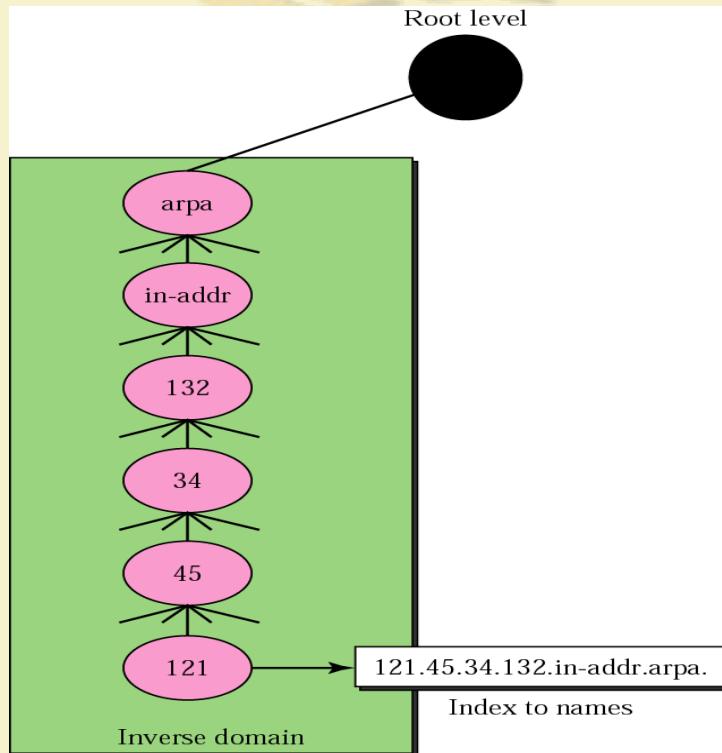
# Generic Domains



# Country Domains



# Inverse Domain



# Name Resolution



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# Name Resolution Process

- The commonly used server is BIND (Berkeley Internal Name Domain).
  - Runs under UNIX as a process called `named`.
- When an application needs some information from the server, it invokes the DNS name resolver.
  - DNS translates a fully qualified domain name into the corresponding IP address.
  - Using the command `nslookup`.



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# Name Resolution Process (contd...)

- If the name server does not have the information locally, it asks its primary server, and so on.
- For redundancy, each host may also have one or more secondary name servers which may be queried when the primary fails.
- “nslookup” command

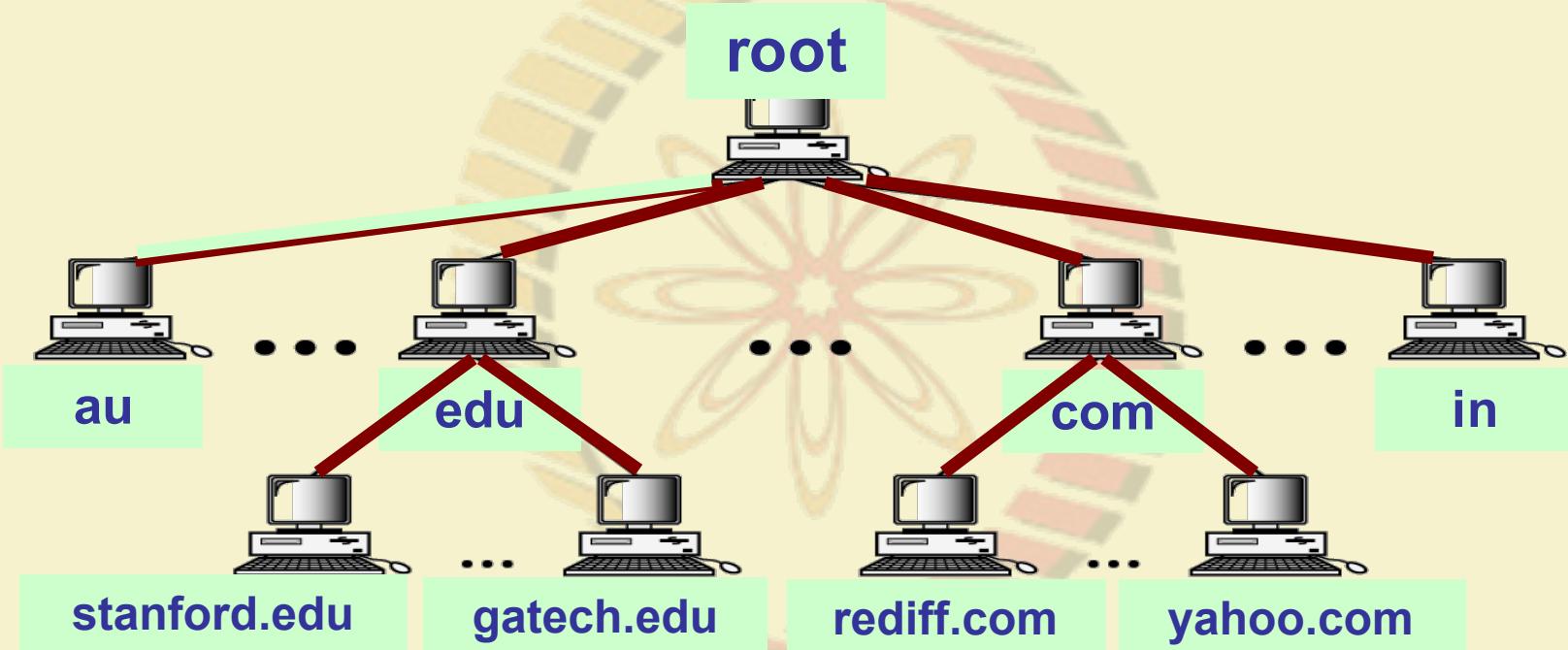


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# Hierarchy of Name Servers

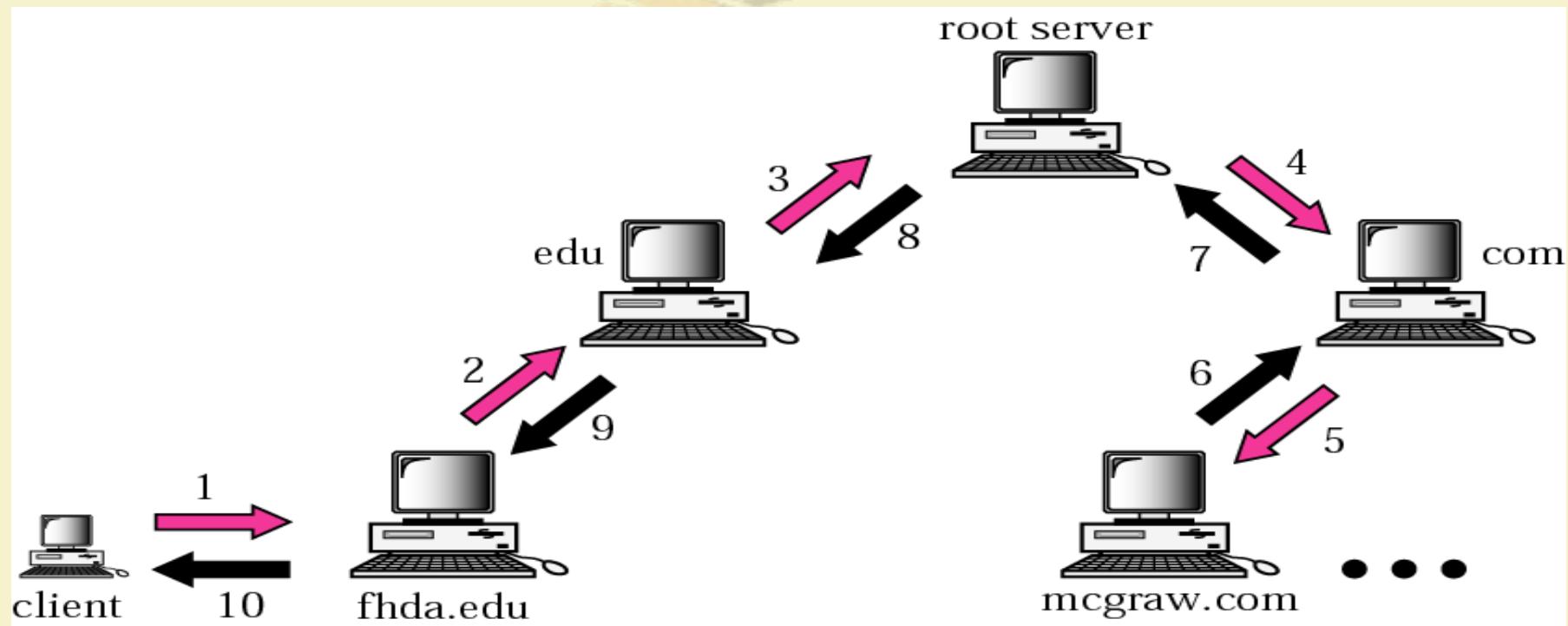


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# Recursive Resolution



# Iterative Name Resolution

- Client sequentially sends queries to DNS servers and receives response.
  - If response is negative, the DNS server to query next is also returned.
  - Unlike recursive name resolution, where only one response is finally returned back to the client.

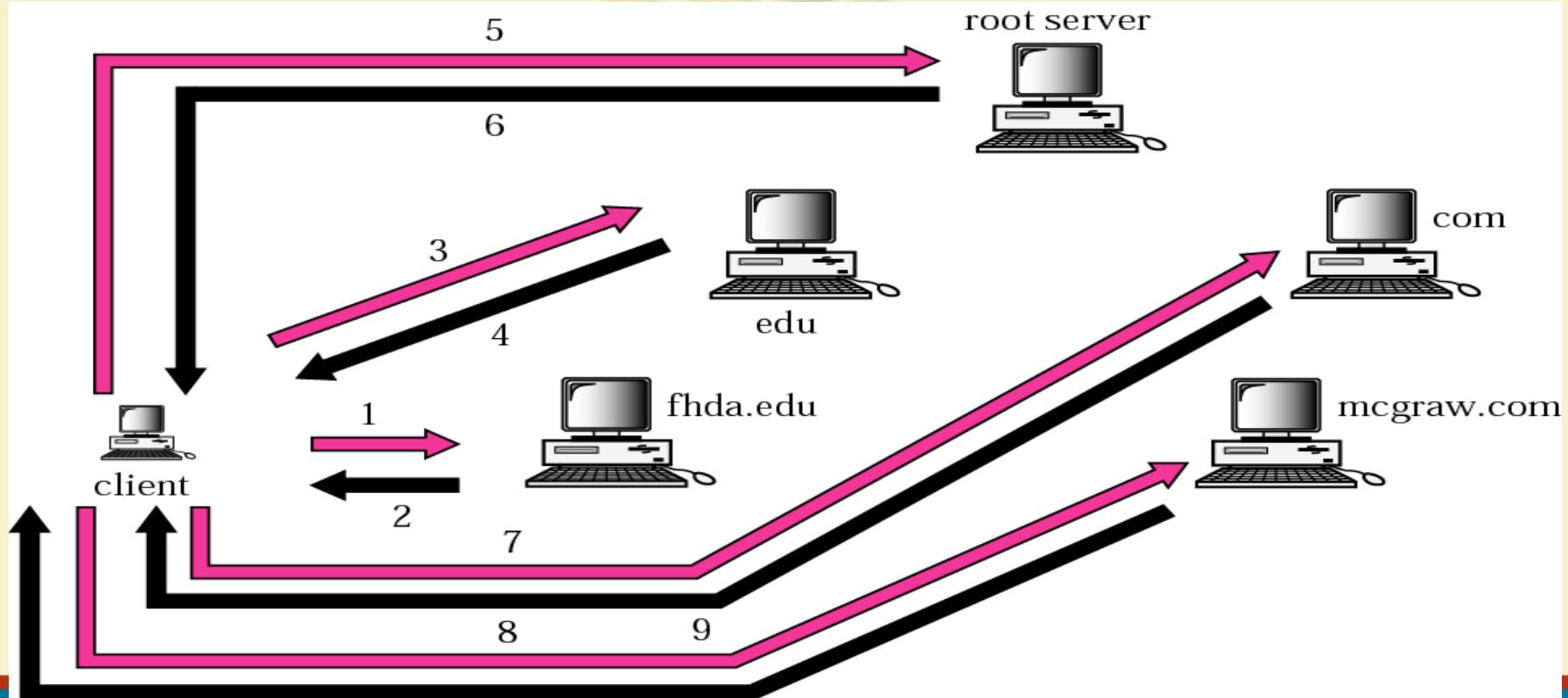


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# Iterative Resolution



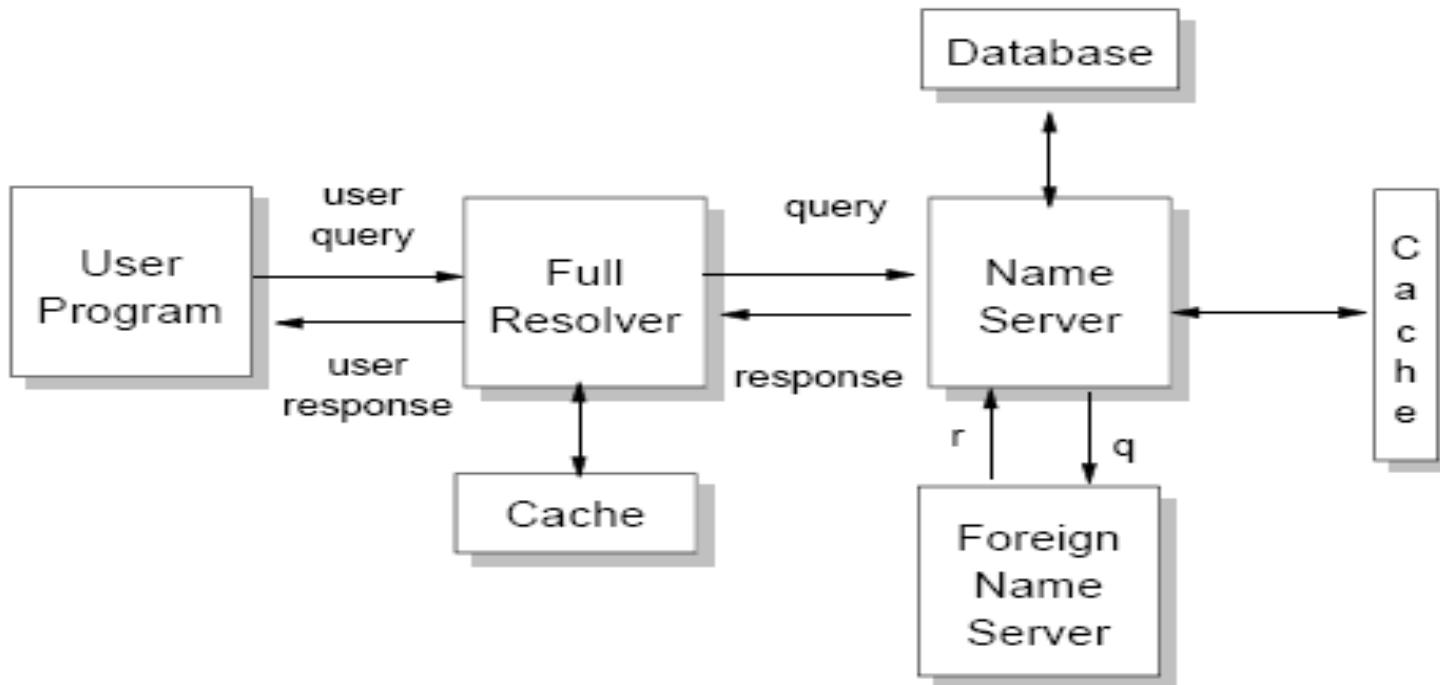
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# DNS Full Resolver



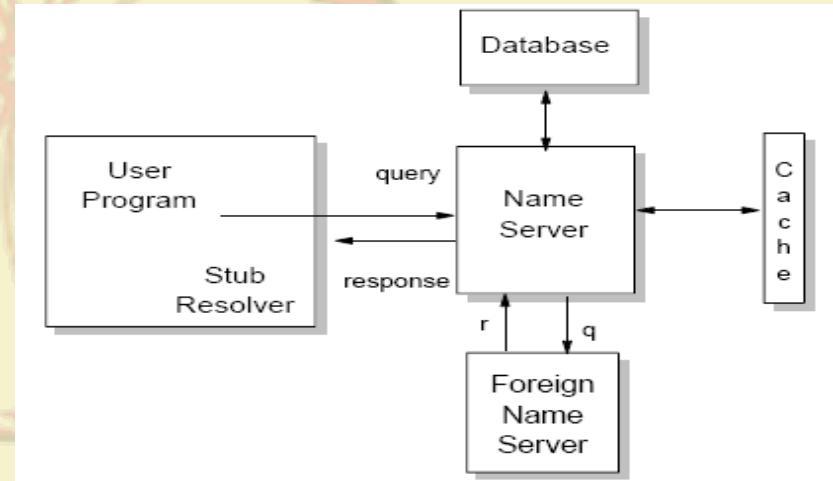
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# Domain name stub resolver

- *Stub resolver*, a routine linked with the user program, that forwards the queries to a name server for processing.
- On most platforms, the stub resolver is implemented by two library routines (or by some variation of these routines): **gethostbyname()** and **gethostbyaddr()**.



# DNS Messages



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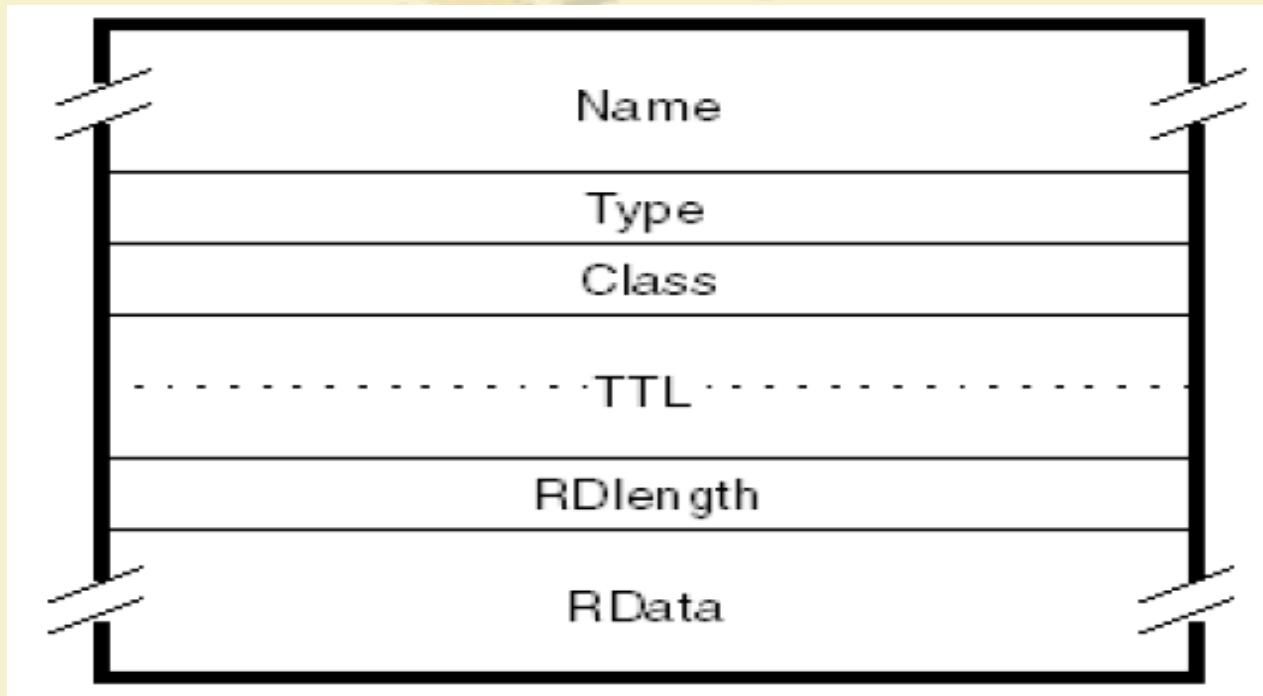


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# DNS Resource Records (RR)

- Domain Name System's distributed database is composed of *resource records (RRs)*, which are divided into classes for different kinds of networks.
- Resource records provide a mapping between domain names and *network objects*.
- *The most common network objects* are the addresses of Internet hosts, but the Domain Name System is designed to accommodate a wide range of different objects.
- A zone consists of a group of resource records, beginning with a Start of Authority (SOA) record.
- The SOA record identifies the domain name of the zone.
- There will be a name server (NS) record for the primary name server for this zone. There might also be NS records for the secondary name servers.
- The NS records are used to identify which of the name servers are authoritative.

# DNS Resource Records (RR)

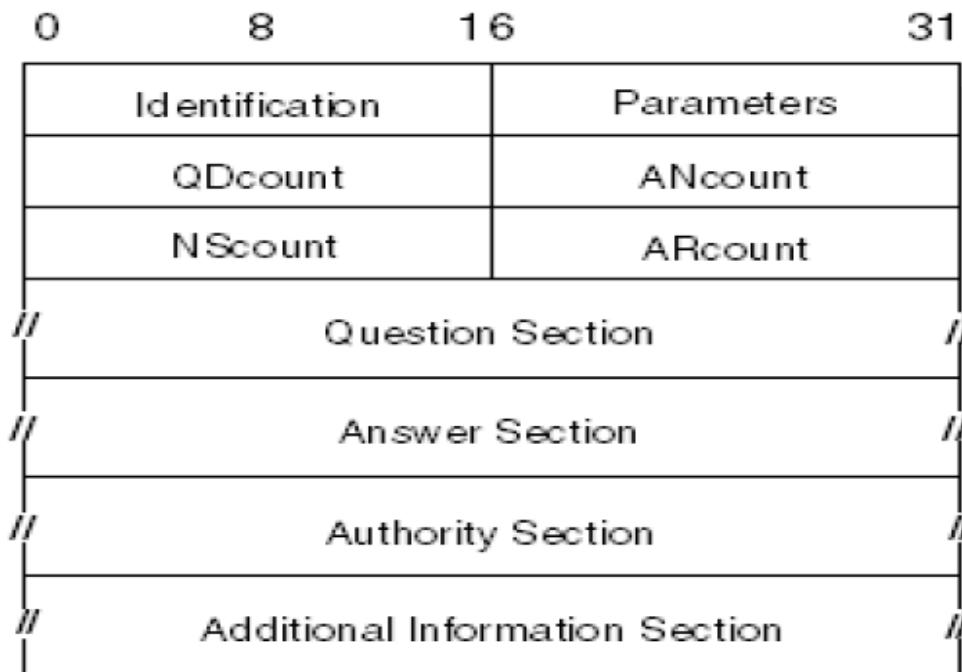


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# DNS RR Message Format

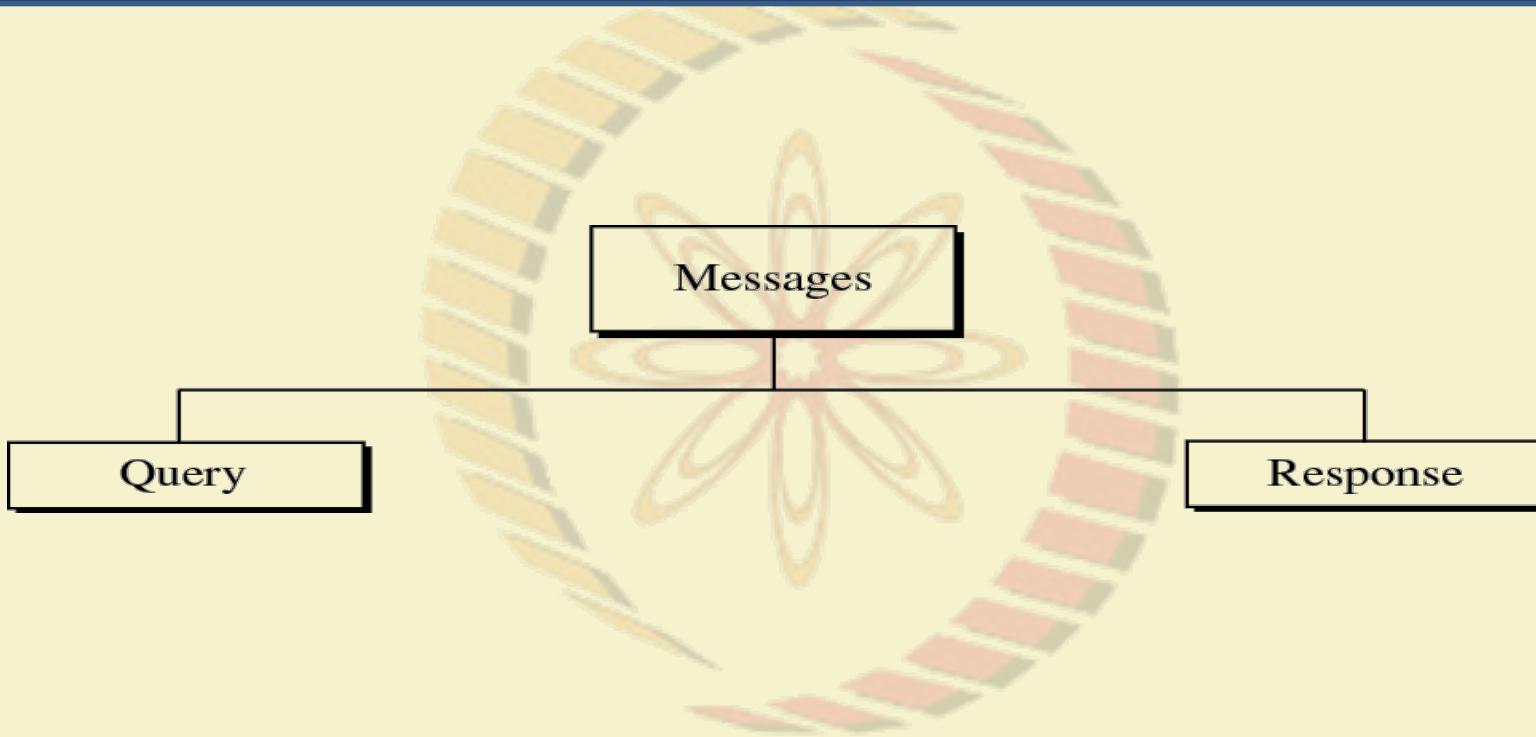


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# DNS Messages

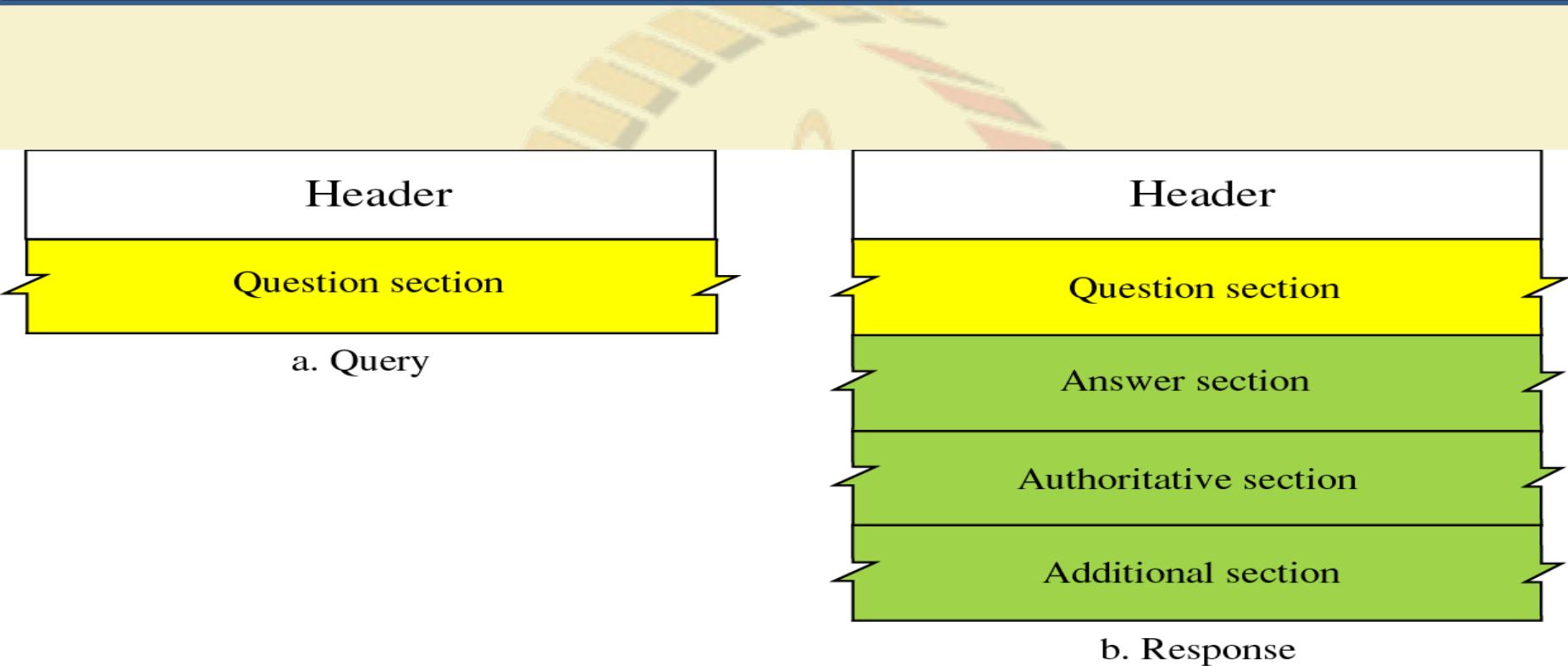


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# Query and Response Messages



# Header Format

Identification	Flags
Number of question records	Number of answer records (All 0s in query message)
Number of authoritative records (All 0s in query message)	Number of additional records (All 0s in query message)

# Flag Fields



QR: Query/Response

OpCode: 0 standard, 1 inverse, 2 server status

AA: Authoritative

TC: Truncated

RD: Recursion Desired

RA: Recursion Available

rCode: Status of the error



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# Types of Records



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# Question Record Format

Query name	
Query type	Query class

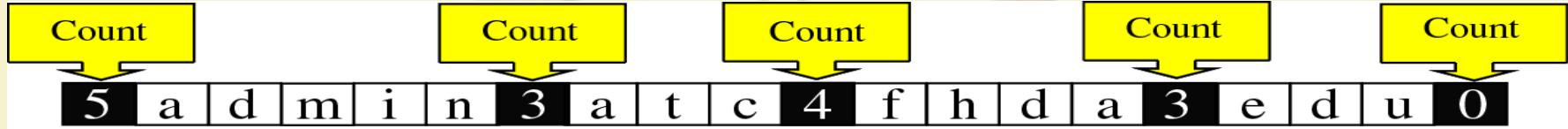


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# Query Name Format



admin.atc.fhda.edu.

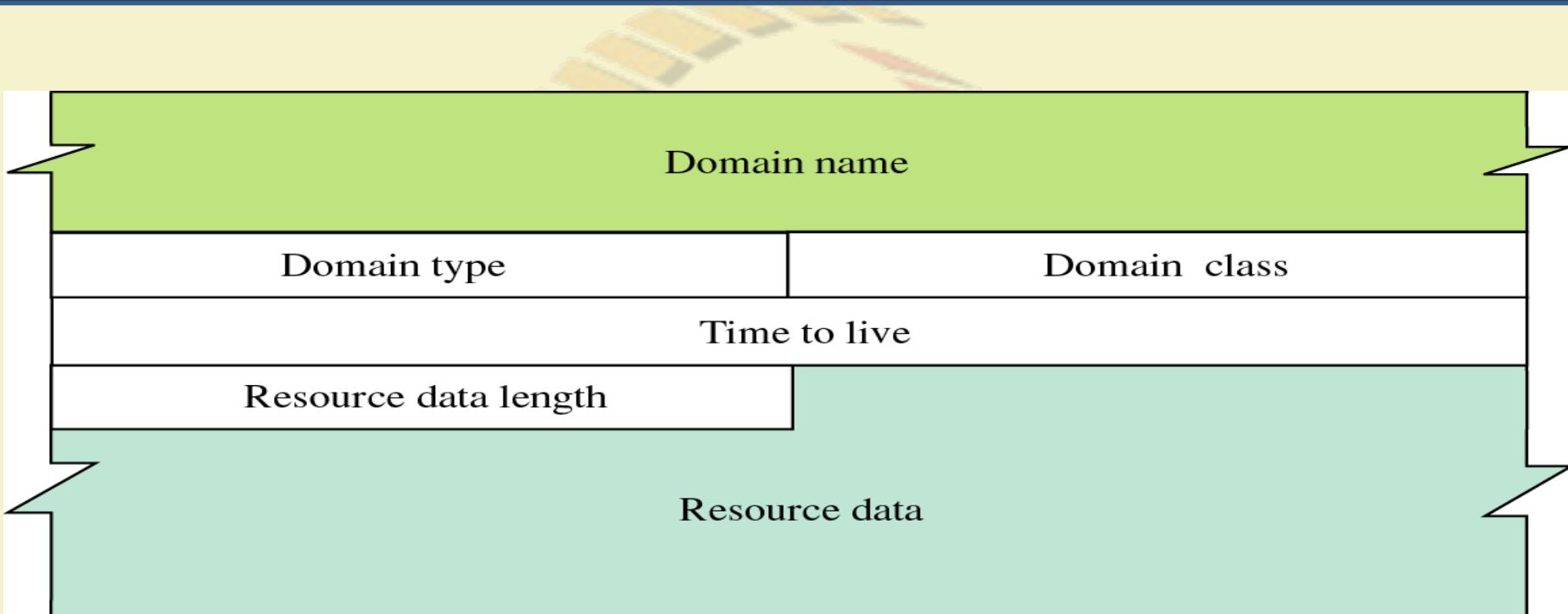


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# Resource Record Format



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# Example 1

- A resolver sends a query message to a local server to find the IP address for the host “[chal.fhda.edu](#)”. We discuss the query and response messages separately.



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# Example 1: The Query Message

0x1333	0x0100
1	0
0	0
4	'c'
'T'	4
'd'	'a'
'd'	'u'
1	1

Continued on  
next line



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# Example 1: The Response Message

0x1333	0x8180	
1	1	
0	0	
4 'T' 'd' 'd'	'c' 4 'a' 'u'	'h' 'f' 3 0
1	1	0xC0
0x0C	1	Continued on next line
1	12000	Continued on next line
	4	153
18	8	105



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# Example 2

- An FTP server has received a packet from an FTP client with IP address **153.2.7.9**. The FTP server wants to verify that the FTP client is an authorized client.



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## Example 2: Inverse Query Message

0x1200	0x0900		
1	0		
0	0		
1	'9'	1	'7'
1	'2'	3	'1'
'5'	'3'	7	'i'
'n'	'_'	'a'	'd'
'd'	'r'	4	'a'
'r'	'p'	'a'	0
12		1	

## Example 2: Inverse Response Message

	0x1200	0x8D80	
	1	1	
	0	0	
→	1 1 '5' 'n' 'd' 'r'	'9' '2' '3' '_' 'r' 'p'	1 3 7 'a' 4 'a'
	12 0xC00C 1 24000 4 'e' 'm'	1 12 Continued on next line 10 'h' 'c' 'o'	0



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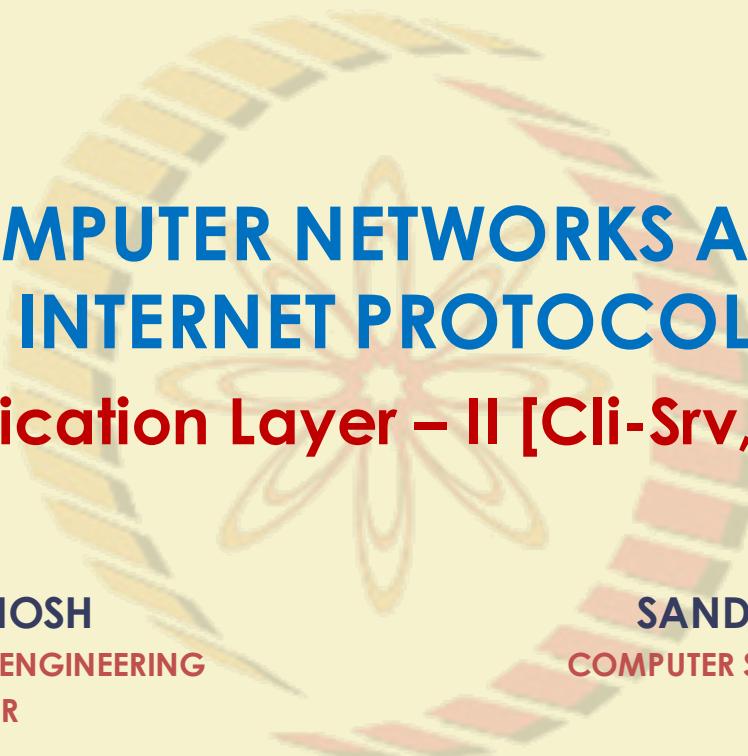
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# **COMPUTER NETWORKS AND INTERNET PROTOCOLS**

## **Application Layer – II [Cli-Srv, FTP]**

**SOUMYA K GHOSH**

COMPUTER SCIENCE AND ENGINEERING  
IIT KHARAGPUR

**SANDIP CHAKRABORTY**

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# Client-Server Model



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# Client-server Model

- Standard model for developing network applications.
- Notion of client and server.
  - A server is a process that is offering some service.
  - A client is a process that is requesting the service.
  - Server or client may be running on different machines.
  - Server waits for requests from client(s).

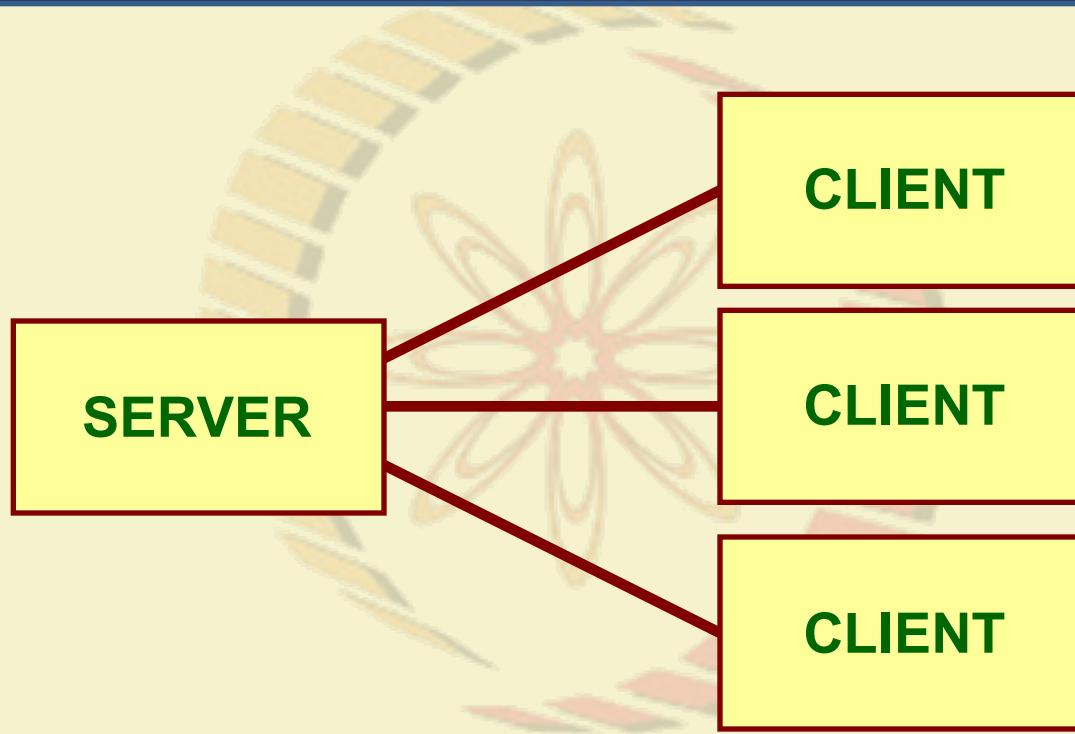


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# Client-Server Model (contd.)



# Client-Server Model (contd.)

- Typical scenario:
  - The server process starts on some computer system.
    - Initializes itself, then goes to sleep waiting for a client request.
  - A client process starts, either on the same system or on some other system.
    - Sends a request to the server.

# Client-Server Model (contd.)

- When the server process has finished providing its service to the client, the server goes back to sleep, waiting for the next client request to arrive.
- The process repeats.



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# Client-Server Model (contd.)

- Roles of the client and the server processes are asymmetric.
- Two types of servers:
  - *Iterative servers.*
  - *Concurrent servers.*

# Iterative Servers

- Used when the server process knows in advance how long it takes to handle each request and it handles each request itself.
  - Single copy of server runs at all times.
  - A client may have to wait if the server is busy.

# Concurrent Servers

- Used when the amount of work required to handle a request is unknown; the server starts another process to handle each request.
  - A copy of the server caters to a client's request in a dedicated fashion.
  - As many copies of server as there are client requests.



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# Using TCP or UDP

- Before start of communication, a connection has to be established between the two hosts.
- Five components in a connection:
  - Protocol used
  - Source IP address
  - Source port number
  - Destination IP address
  - Destination port number



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# Develop a Network Application

- The best way is to use some standard and well-accepted protocol.
  - At the data link layer level, use **Ethernet**.
  - At the network layer level, use **IP**.
  - At the transport layer level, use **TCP**.
  - At the application layer level, use a standard API like the **Berkeley Socket Interface**.



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# What is a Socket?

- The socket is the method for achieving inter-process communication (IPC).
- It is used to allow one process to speak to another (on same or different machine).
  - *Analogy:* Like the telephone is used to allow one person to speak to another.

# Socket - Basic Idea

- When two processes located on two machines communicate, we define association and socket.
  - *Association*: basically a 5-tuple
    - Protocol
    - Local IP address
    - Local port number
    - Remote IP address
    - Remote port number

# Socket - Basic Idea

- Socket: also called half-association (a 3-tuple)
  - Protocol, local IP address, local port number
  - Protocol, remote IP address, remote port number



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# File Transfer Protocol (FTP)



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# FTP

- Facilitates transfer of files over network
- Server/Client model
- FTP often works with
  - Transmission Control Protocol (TCP)
  - Telnet Protocol
- Defined as RFC959



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# Overview of FTP

- FTP uses TCP as a transport protocol to provide reliable end-to-end connections and implements two types of connections in managing data transfers.
- The FTP client initiates the first connection, referred to as the control connection, to well-known port 21 (the client's port is typically ephemeral). It is on this port that an FTP server listens for and accepts new connections.
- The control connection is used for all of the control commands a client user uses to log on to the server, manipulate files, and terminate a session. This is also the connection across which the FTP server will send messages to the client in response to these control commands.

Ref: IBM Redbooks

# Overview of FTP (contd.)

- The second connection used by FTP is referred to as the data connection.
- Typically, the data connection is established on server port 20. However, depending on how the data connection is established, both the client and server might use ephemeral ports.
- FTP transfers the data over data connection. FTP only opens a data connection when a client issues a command requiring a data transfer, such as a request to retrieve a file, or to view a list of the files available. It is possible for an entire FTP session to open and close without a data connection ever having been opened.
- The data connection is unidirectional. FTP can transfer data only from the client to the server, or from the server to the client, but not both.
- The data connection can be initiated from either the client or the server. Data connections initiated by the server are active, while those initiated by the client are passive.

# FTP – Basic working

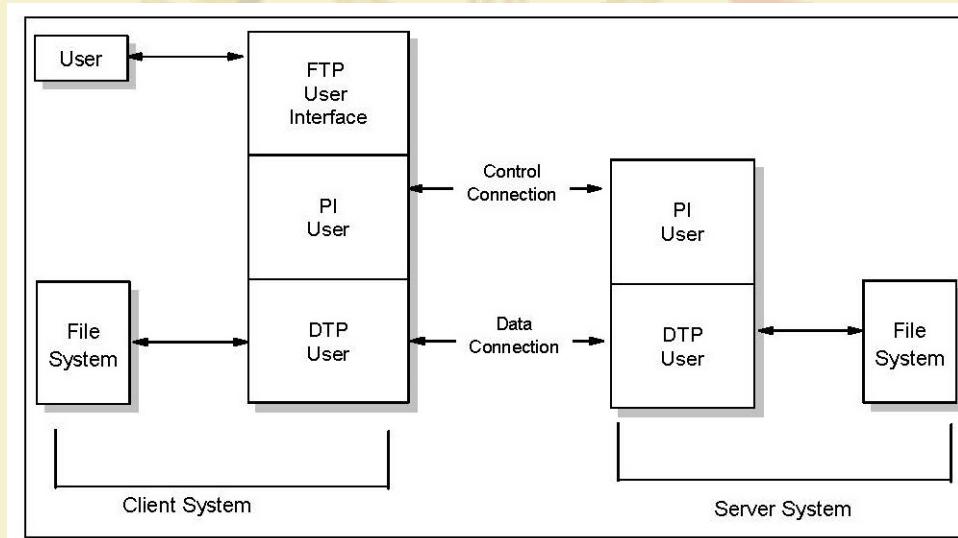
- FTP has to be on both server and client computers to work
- Connection
  - Control connection (port 21)
    - Used to send and receive FTP commands
  - Data connection (port 20)
    - Used to upload and download files
- Processes
  - Data Transfer Process (DTP)
    - Establishing the connection and managing the data channel
  - Protocol Interpreter (PI)
    - Interprets the protocol
    - let DTP be controlled using commands received over the control channel

# FTP – Basic working (contd.)

- Transferring mode between server and client
  - Active mode
    - Control connection port: Client: Large port ( $N > 1023$ ); Server: 21
    - Data connection port: Client:  $N + 1$ ; Server: 20
  - Passive mode
    - Control connection port: Client: Large port ( $N > 1023$ ); Server: 21
    - Data connection port: Client:  $N + 1$ ; Server: large port ( $P > 1023$ )
- File Transferring mode
  - ASCII mode
    - .txt, .html, .asp, .vbs, .js
  - Binary
    - .doc, .pdf, .mp3/mp4

# FTP – Basic working (contd.)

- The client FTP application is built with a protocol interpreter (PI), a data transfer process (DTP), and a user interface.
- The server FTP application typically only consists of a PI and DTP



Ref: IBM Redbooks

# FTP – Basic working (contd.)

- FTP client's user interface communicates with the protocol interpreter (PI), which manages the control connection.
- PI translates any application-specific commands to the RFC architected FTP commands, and then communicates these control commands to the FTP server.
- The FTP server's PI receives these commands, and then initiates the appropriate processes to service the client's requests. If the requests require the transfer of data, data management is performed by the DTPs on both the client and server applications.
- After the completion of the data transfer, the data connection is closed, and control is returned to the PIs of the client and server applications.
- Only one data transfer can occur for each data connection. If multiple data transfers are required for a single FTP session, one distinct control connection will be opened for each transfer.

Ref: IBM Redbooks

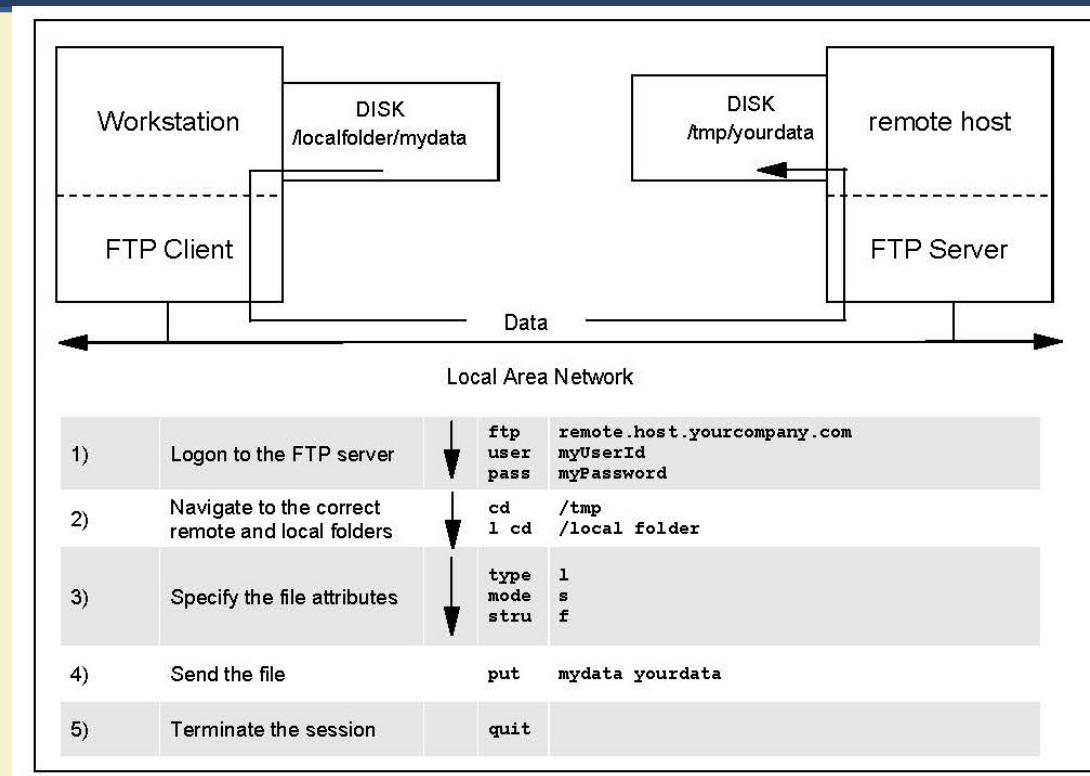
# FTP Operation – User's Perspective

When using FTP, the user performs some or all of the following operations:

- Connect to a remote host.
- Navigate and manipulate the directory structure.
- List files available for transfer.
- Define the transfer mode, transfer type, and data structure.
- Transfer data to or from the remote host.
- Disconnect from the remote host.

*Ref: IBM Redbooks*

# A Typical FTP scenario



Ref: IBM Redbooks

# Trivial File Transfer Protocol (TFTP)

- TFTP file transfer is a disk-to-disk data transfer, and is a simple protocol used to transfer files. The simplicity of the architecture is deliberate in order to facilitate ease of implementation.
- This simplistic approach has many benefits over traditional FTP, including:
  - Use by diskless devices to download firmware at boot time
  - Use by any automated process for which the assignment of a user ID or password is not feasible
  - Small application size, allowing it to be implemented inexpensively and in environments where resources are constricted
- TFTP is implemented on top of the User Datagram Protocol.
- The TFTP client initially sends read/write request through well-known port 69. The server and the client then determine the port that they will use for the rest of the connection.
- TFTP lacks most of the features of FTP, and instead is limited to only reading a file from a server or writing a file to a server.
- TFTP has no provisions for user authentication; in that respect, it is an insecure protocol.

Ref: IBM Redbooks

# FTP – Access Commands

<i>Command</i>	<i>Argument(s)</i>	<i>Description</i>
<b>USER</b>	User id	User information
<b>PASS</b>	User password	Password
<b>ACCT</b>	Account to be charged	Account information
<b>REIN</b>		Reinitialize
<b>QUIT</b>		Log out of the system
<b>ABOR</b>		Abort the previous command

Ref: TCP/IP Protocol Suite



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# FTP – File Management Commands

<i>Command</i>	<i>Argument(s)</i>	<i>Description</i>
<b>CWD</b>	Directory name	Change to another directory
<b>CDUP</b>		Change to the parent directory
<b>DELE</b>	File name	Delete a file
<b>LIST</b>	Directory name	List subdirectories or files
<b>NLIST</b>	Directory name	List the names of subdirectories or files without other attributes
<b>MKD</b>	Directory name	Create a new directory
<b>PWD</b>		Display name of current directory
<b>RMD</b>	Directory name	Delete a directory
<b>RNFR</b>	File name (old file name)	Identify a file to be renamed
<b>RNTO</b>	File name (new file name)	Rename the file
<b>SMNT</b>	File system name	Mount a file system

Ref: TCP/IP Protocol Suite

# FTP – Data Formatting Commands

<i>Command</i>	<i>Argument(s)</i>	<i>Description</i>
<b>TYPE</b>	A (ASCII), E (EBCDIC), I (Image), N (Nonprint), or T (TELNET)	Define the file type and if necessary the print format
<b>STRU</b>	F (File), R (Record), or P (Page)	Define the organization of the data
<b>MODE</b>	S (Stream), B (Block), or C (Compressed)	Define the transmission mode

Ref: TCP/IP Protocol Suite

# FTP – File Transfer Commands

<i>Command</i>	<i>Argument(s)</i>	<i>Description</i>
<b>RETR</b>	File name(s)	Retrieve files; file(s) are transferred from server to the client
<b>STOR</b>	File name(s)	Store files; file(s) are transferred from the client to the server
<b>APPE</b>	File name(s)	Similar to STOR except if the file exists, data must be appended to it
<b>STOU</b>	File name(s)	Same as STOR except that the file name will be unique in the directory; however, the existing file should not be overwritten

<i>Command</i>	<i>Argument(s)</i>	<i>Description</i>
<b>ALLO</b>	File name(s)	Allocate storage space for the files at the server
<b>REST</b>	File name(s)	Position the file marker at a specified data point
<b>STAT</b>	File name(s)	Return the status of files

Ref: TCP/IP Protocol Suite



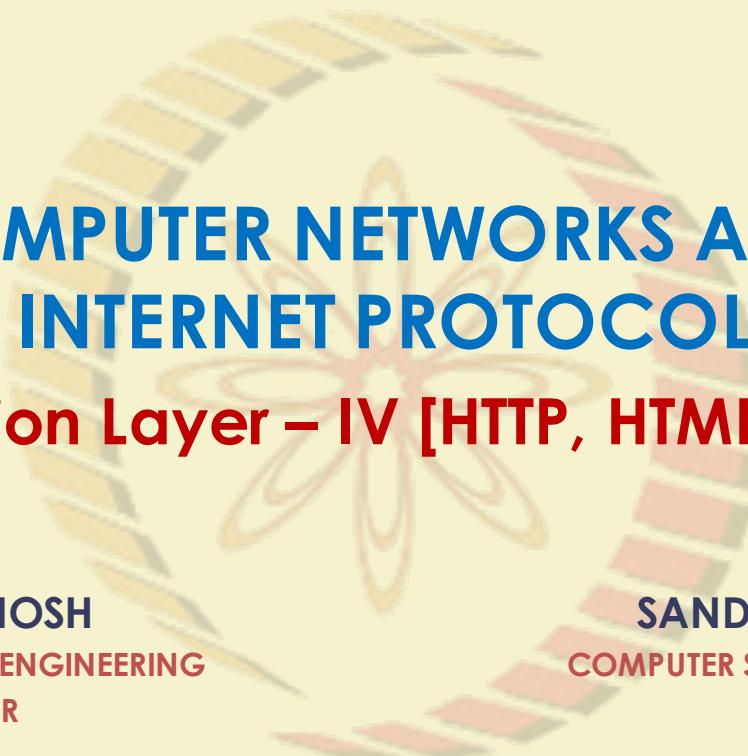
thank you!



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# **COMPUTER NETWORKS AND INTERNET PROTOCOLS**

## **Application Layer – IV [HTTP, HTML, TELNET]**

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COMPUTER SCIENCE AND ENGINEERING  
IIT KHARAGPUR

**SANDIP CHAKRABORTY**

COMPUTER SCIENCE AND ENGINEERING  
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# HyperText Transfer Protocol (HTTP)

- HTTP is the protocol that supports communication between web browsers and web servers.
- A “Web Server” is a HTTP server
- A “Web Browser” is a HTTP client
- Most clients/servers run version 1.1, but 1.0 is also in use.
  - RFC 1945 (HTTP 1.0)
  - RFC 2616 (HTTP 1.1)
- HTTP version 1.1 specifies a persistent connection by default.

# HTTP – Overview

- “HTTP is an application-level protocol with the lightness and speed necessary for distributed, hypermedia information systems.”
- Transport Independence
  - HTTP protocol generally takes place over a TCP connection,
  - However, the protocol itself is not dependent on a specific transport layer.



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# Request - Response

- HTTP has a simple structure:
  - client sends a request
  - server returns a reply.
- HTTP can support multiple request-reply exchanges over a single TCP connection.
- The “well known” TCP port for HTTP servers is port 80.
  - Other ports also can be used



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# ARCHITECTURE

WWW is a distributed client/server service, in which a HTTP client (browser) can access a service from a HTTP server.

- Client (Browser)
- Server
- Uniform Resource Locator
- Cookies

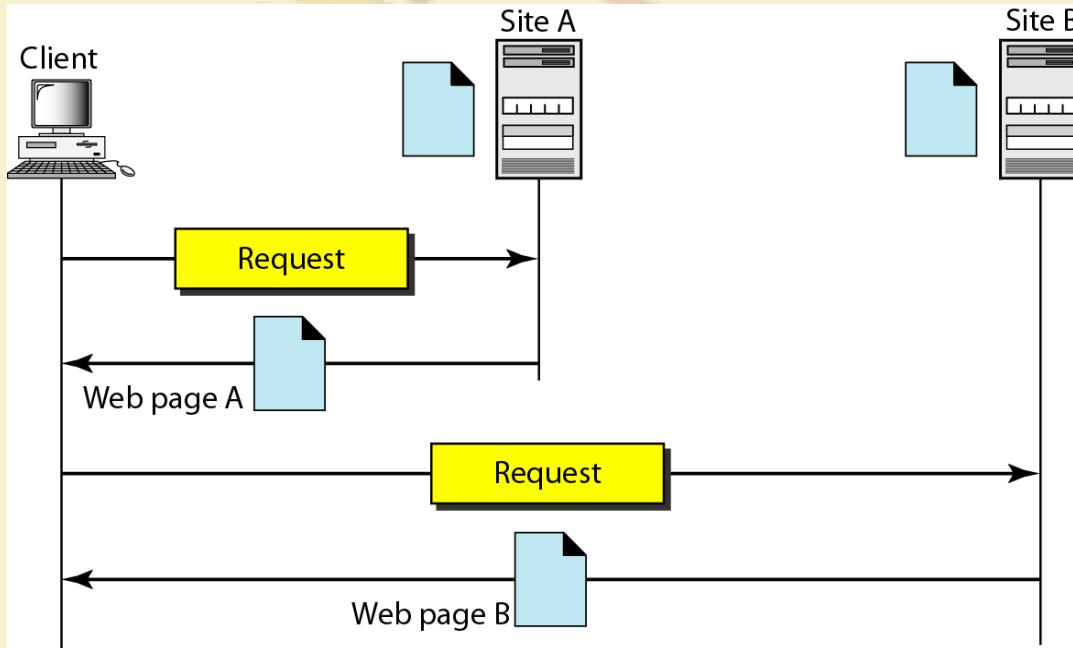


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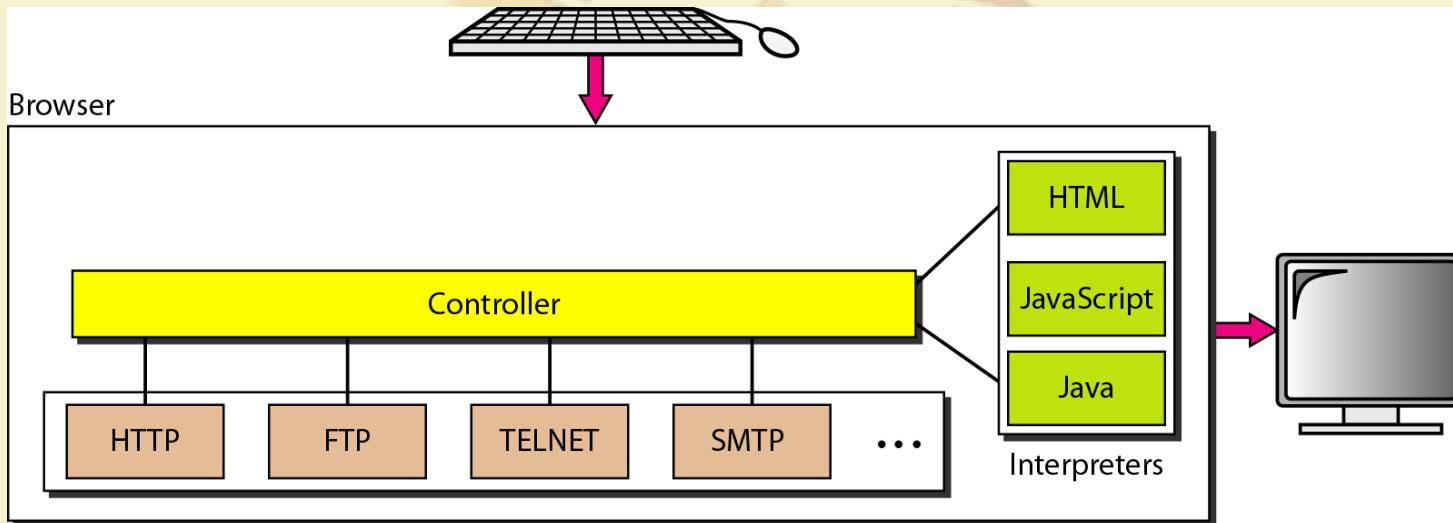
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# Operation



*Ref: Data Communication and Networking, Forouzan*

# HTTP Client (Browser)



*Ref: Data Communication and Networking, Forouzan*

# URL



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# WEB DOCUMENTS

Web documents can be grouped into three broad categories:

- Static
- Dynamic
- Active

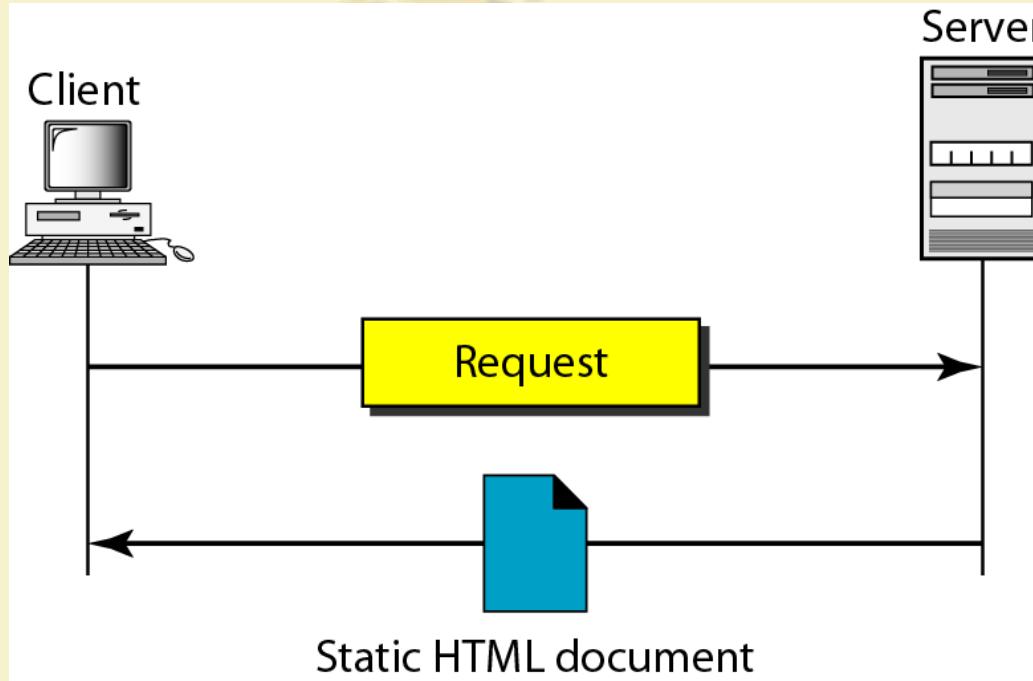


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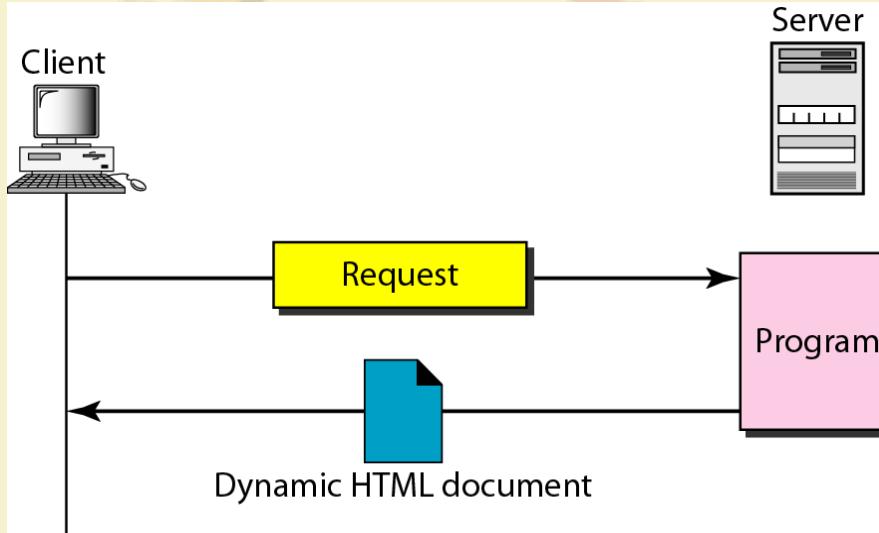
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# Static document

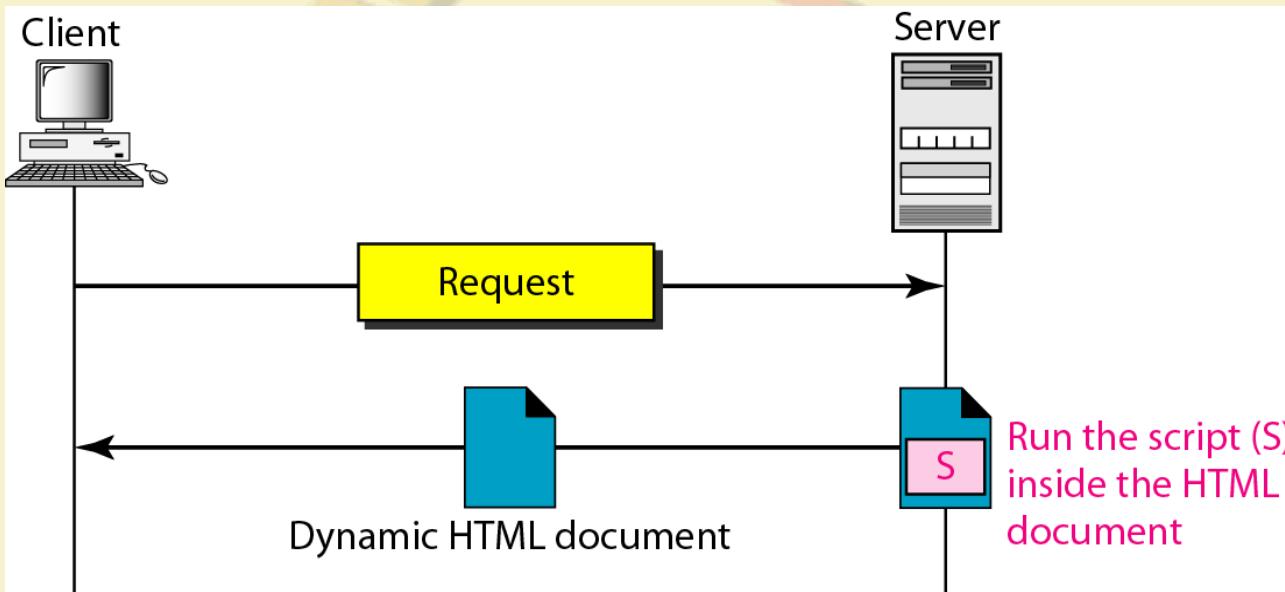


*Ref: Data Communication and Networking, Forouzan*

# Dynamic document using CGI (Common Gateway Interface)

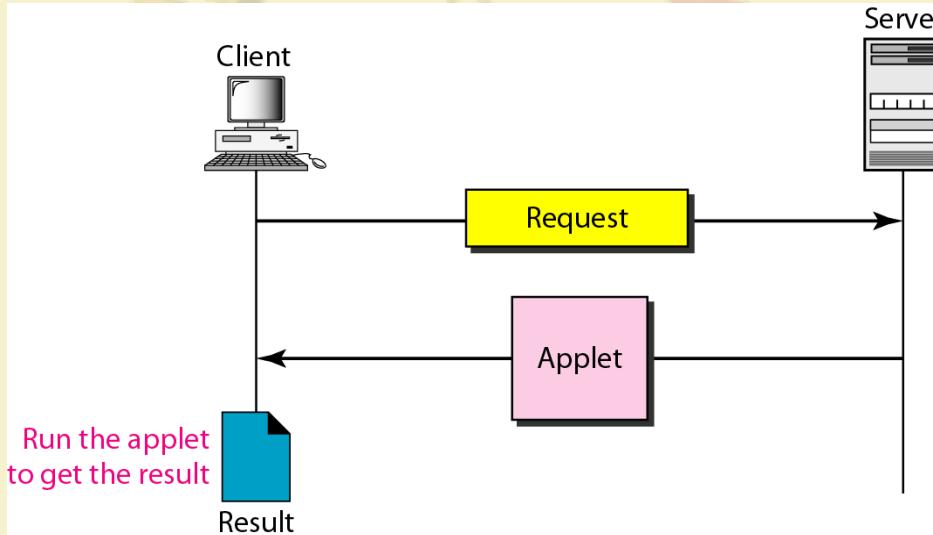


# Dynamic document using Server-site script

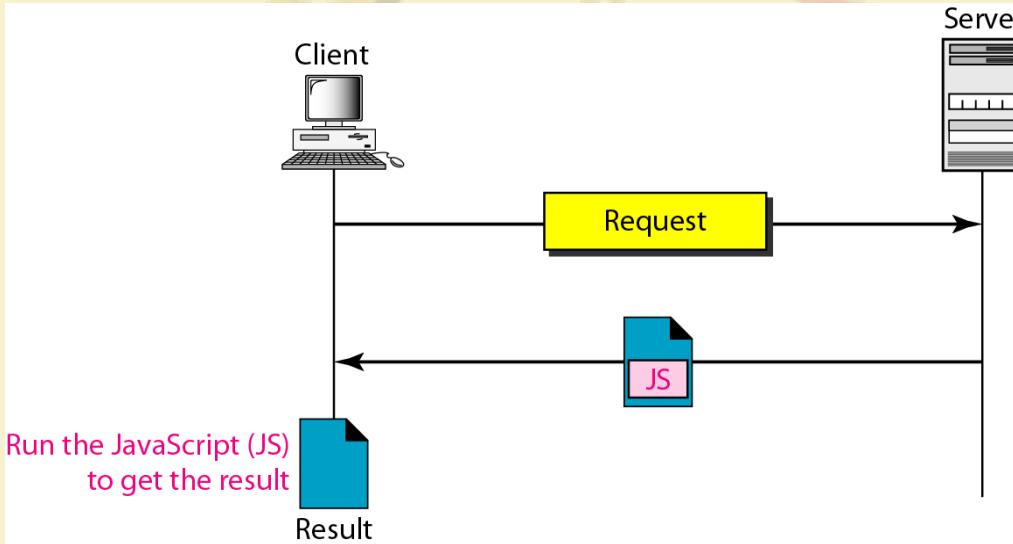


Ref: Data Communication and Networking, Forouzan

# Active document using Java applet



# Active document using Client-site script

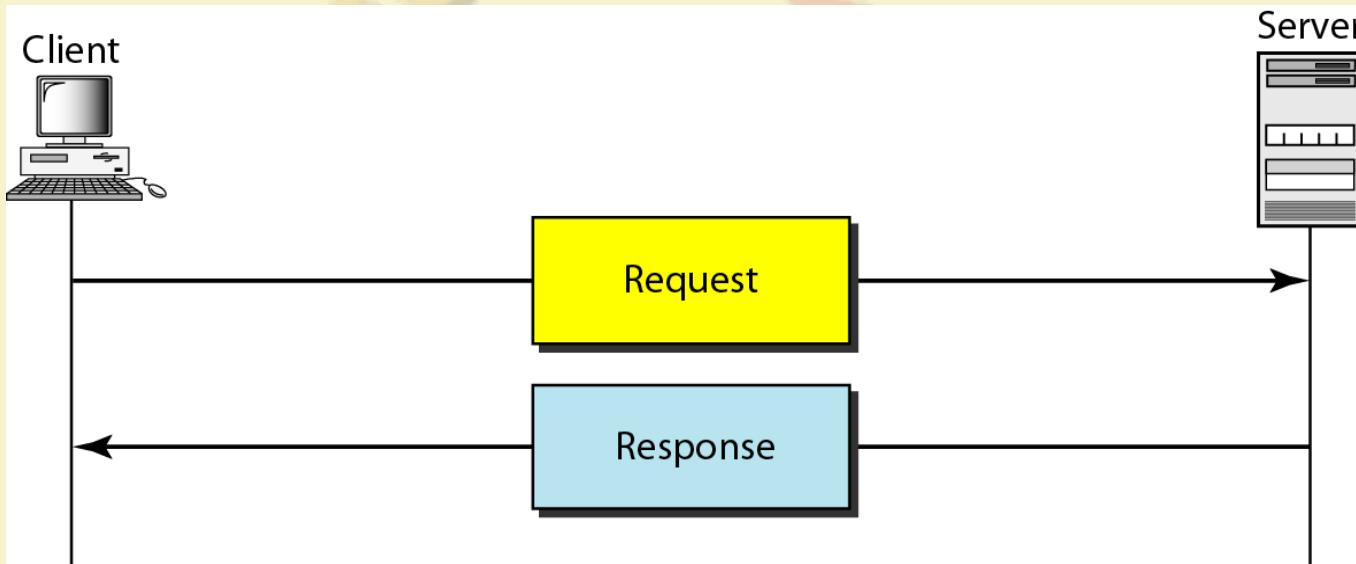


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# HTTP transaction

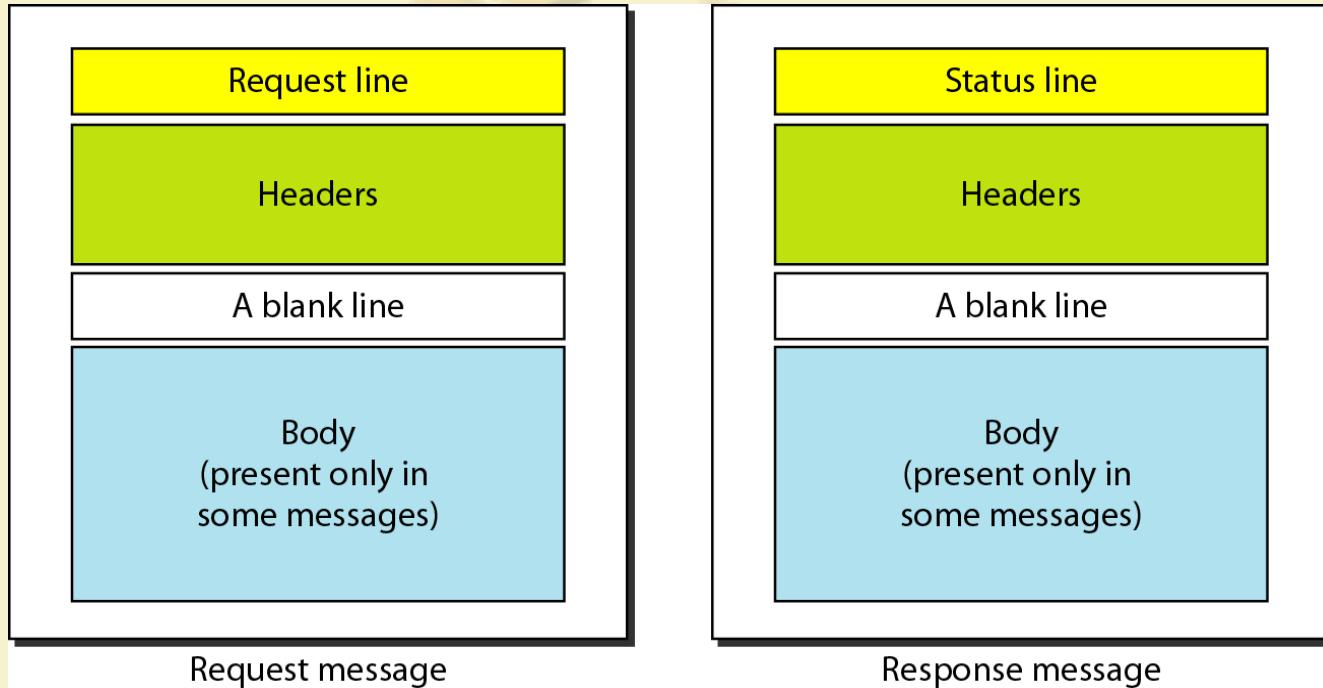


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# HTTP: Request and Response messages



*Ref: Data Communication and Networking, Forouzan*

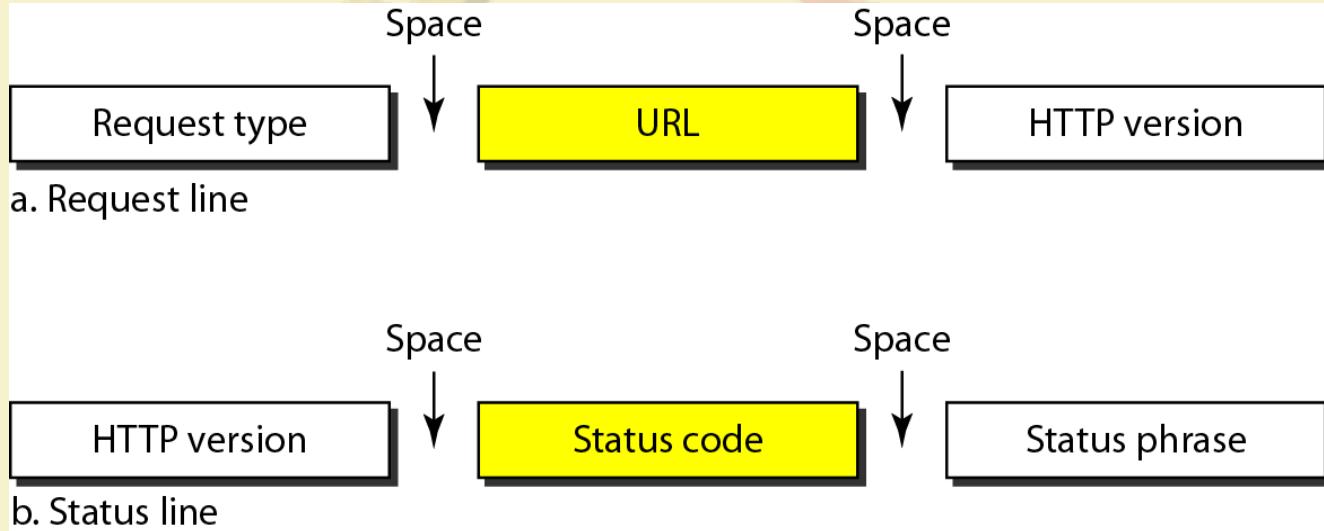


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# HTTP Request and Status lines



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# HTTP Methods

<i>Method</i>	<i>Action</i>
GET	Requests a document from the server
HEAD	Requests information about a document but not the document itself
POST	Sends some information from the client to the server
PUT	Sends a document from the server to the client
TRACE	Echoes the incoming request
CONNECT	Reserved
OPTION	Inquires about available options

*Ref: Data Communication and Networking, Forouzan*

# HTTP Status Codes

<i>Code</i>	<i>Phrase</i>	<i>Description</i>
<b>Informational</b>		
<b>100</b>	Continue	The initial part of the request has been received, and the client may continue with its request.
<b>101</b>	Switching	The server is complying with a client request to switch protocols defined in the upgrade header.
<b>Success</b>		
<b>200</b>	OK	The request is successful.
<b>201</b>	Created	A new URL is created.
<b>202</b>	Accepted	The request is accepted, but it is not immediately acted upon.
<b>204</b>	No content	There is no content in the body.



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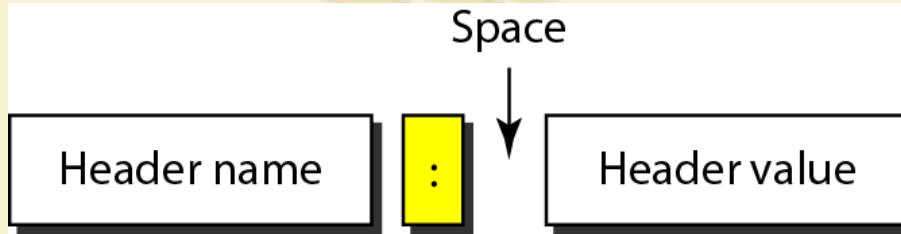


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# HTTP Status Codes (contd...)

<i>Code</i>	<i>Phrase</i>	<i>Description</i>
<b>Redirection</b>		
<b>301</b>	Moved permanently	The requested URL is no longer used by the server.
<b>302</b>	Moved temporarily	The requested URL has moved temporarily.
<b>304</b>	Not modified	The document has not been modified.
<b>Client Error</b>		
<b>400</b>	Bad request	There is a syntax error in the request.
<b>401</b>	Unauthorized	The request lacks proper authorization.
<b>403</b>	Forbidden	Service is denied.
<b>404</b>	Not found	The document is not found.
<b>405</b>	Method not allowed	The method is not supported in this URL.
<b>406</b>	Not acceptable	The format requested is not acceptable.
<b>Server Error</b>		
<b>500</b>	Internal server error	There is an error, such as a crash, at the server site.
<b>501</b>	Not implemented	The action requested cannot be performed.
<b>503</b>	Service unavailable	The service is temporarily unavailable, but may be requested in the future.

# HTTP Header



<i>Header</i>	<i>Description</i>
Cache-control	Specifies information about caching
Connection	Shows whether the connection should be closed or not
Date	Shows the current date
MIME-version	Shows the MIME version used
Upgrade	Specifies the preferred communication protocol



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# Request Headers

<i>Header</i>	<i>Description</i>
Accept	Shows the medium format the client can accept
Accept-charset	Shows the character set the client can handle
Accept-encoding	Shows the encoding scheme the client can handle
Accept-language	Shows the language the client can accept
Authorization	Shows what permissions the client has
From	Shows the e-mail address of the user
Host	Shows the host and port number of the server
If-modified-since	Sends the document if newer than specified date
If-match	Sends the document only if it matches given tag
If-non-match	Sends the document only if it does not match given tag
If-range	Sends only the portion of the document that is missing
If-unmodified-since	Sends the document if not changed since specified date
Referrer	Specifies the URL of the linked document
User-agent	Identifies the client program

# Response Headers

<i>Header</i>	<i>Description</i>
Accept-range	Shows if server accepts the range requested by client
Age	Shows the age of the document
Public	Shows the supported list of methods
Retry-after	Specifies the date after which the server is available
Server	Shows the server name and version number



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# HTTP: Entity headers

<i>Header</i>	<i>Description</i>
Allow	Lists valid methods that can be used with a URL
Content-encoding	Specifies the encoding scheme
Content-language	Specifies the language
Content-length	Shows the length of the document
Content-range	Specifies the range of the document
Content-type	Specifies the medium type
Etag	Gives an entity tag
Expires	Gives the date and time when contents may change
Last-modified	Gives the date and time of the last change
Location	Specifies the location of the created or moved document

## Example 1

This example retrieves a document. We use the GET method to retrieve an image with the path /usr/bin/image1. The request line shows the method (GET), the URL, and the HTTP version (1.1).

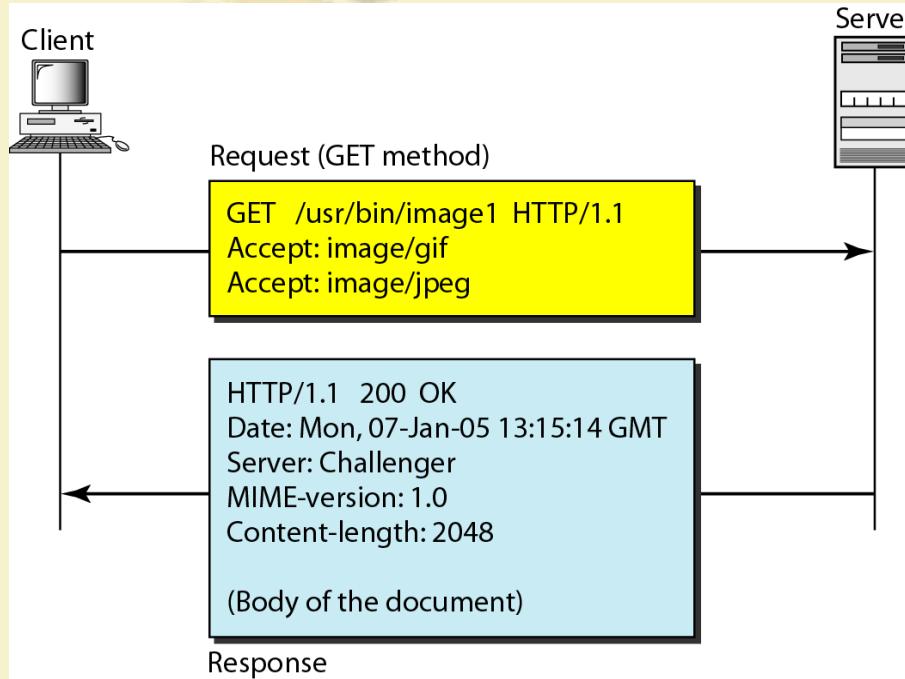
The header has two lines that show that the client can accept images in the GIF or JPEG format. The request does not have a body. The response message contains the status line and four lines of header. The header lines define the date, server, MIME version, and length of the document. The body of the document follows the header.



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## Example 2

*In this example, the client wants to send data to the server. Use the POST method. The request line shows the method (POST), URL, and HTTP version (1.1). There are four lines of headers. The request body contains the input information. The response message contains the status line and four lines of headers. The created document, which is a CGI document, is included as the body*

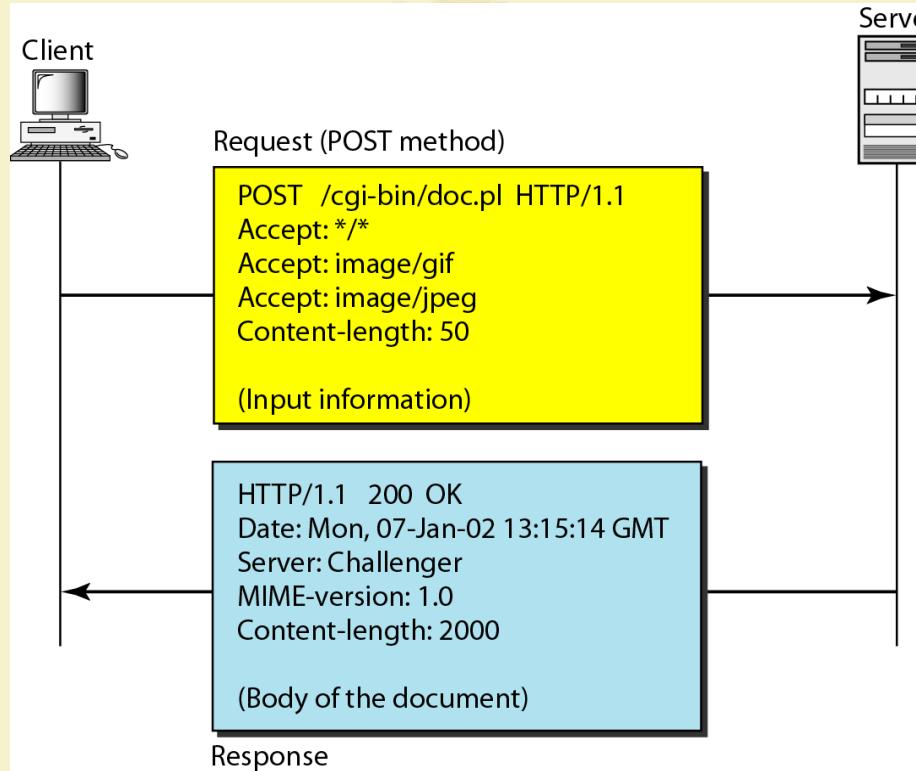


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## Example 2



# Connecting HTTP server using TELNET

```
$ telnet www.mhhe.com 80
```

```
Trying 198.45.24.104 ...
```

```
Connected to www.mhhe.com (198.45.24.104).
```

```
Escape character is '^]'.  
GET /engcs/compsci/forouzan HTTP/1.1
```

```
From: forouzanbehrouz@fhda.edu
```

**HTTP/1.1 200 OK**

**Date: Thu, 28 Oct 2004 16:27:46 GMT**

**Server: Apache/1.3.9 (Unix) ApacheJServ/1.1.2 PHP/4.1.2 PHP/3.0.18**

**MIME-version:1.0**

**Content-Type: text/html**

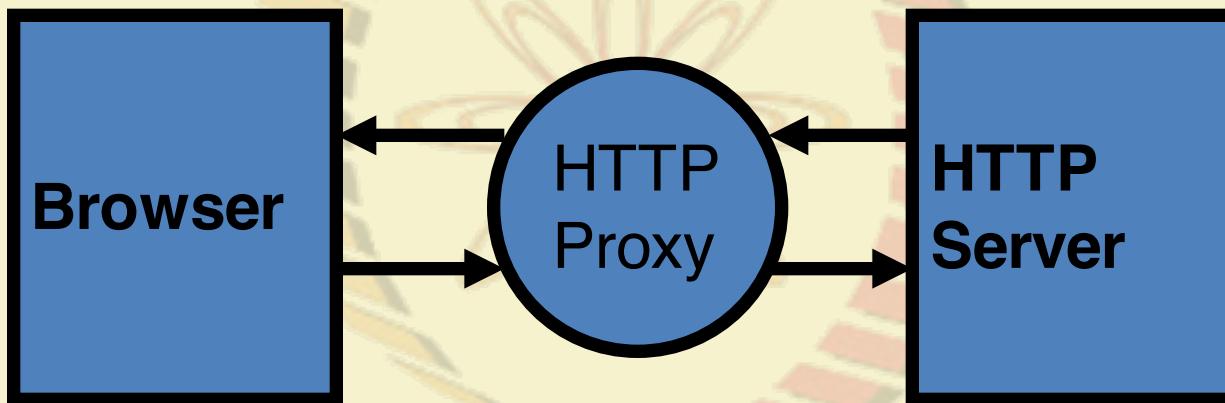


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# HTTP Proxy Server



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# HTML



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# What is HTML?

- Stands for Hyper Text Markup Language
- Computer language used to create web pages
- HTML file = text file containing markup tags such <p>
- Tags tell Web browser how to display a page
- Can have either \*.htm or \*.html file extension



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# HTML Elements

- Tags are the elements that create the components of a page
- Tags surrounded by angle brackets < >
- Usually come in pairs
  - Example: Start tag <p> and end tag </p>
- Stuff between is called “element content”
- Tags are not case sensitive
  - New standard is to use lower case



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# Your created HTML document

```
<html>  
  <head>  
    <title> ...document title... </title>  
  </head>  
  <body>  
    ...your page content...  
  </body>  
</html>
```



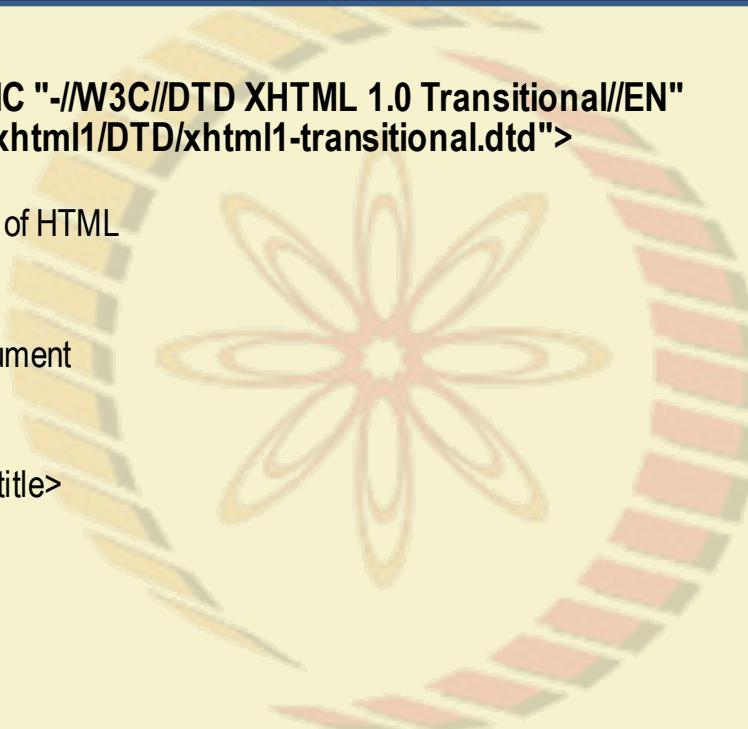
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# Page Components

- <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"  
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
  - First line of code
  - Declaration of version of HTML
- <html>...</html>
  - Container for the document
- <head>...</head>
  - <title> Title of page </title>
- <body>...</body>
  - Content of page



```
<html>
  <head>
    <title>...document  
title... </title>
  </head>
  <body>
    ...your page content...
  </body>
</html>
```

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Type here to search



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# Basic Tags

- Headings
  - `<h1>...</h1>` to `<h6>...</h6>`
  - Like in Word
- Paragraph
  - `<p>... </p>`
  - Inserts a line space before and after a paragraph



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# Example of use of Heading

UNIVERSITY OF HAWAII AT MĀNOA LIBRARY

Home | Research Tools | Personal Services | About the Library

Ask Us | Find Books & Media | Your Account |  Site Search

**Library Exhibits**

Exhibits on themes or events of interest to the community are regularly displayed at Hamilton and Sinclair Libraries with the goal of informing our users about the resources at the University of Hawai'i at Manoa libraries. The Exhibits Committee coordinates and facilitates displays in Hamilton and Sinclair Libraries according to the [Exhibits Policy](#). Exhibits are accepted on well-thought out themes, preferably scholarly in nature. Anyone interested in providing an exhibit may complete the [Request to Display in Library](#) form. Floor plans for the [Phase II Gallery](#) and the [Bridge Gallery](#) display the layout and dimensions for each gallery.

For upcoming exhibits at Hamilton Library please view the [Main Exhibits Calendar](#). In addition to the main exhibits, visit the department display cases in Asia Collection, Science and Technology, and Special Collections.

**Featured Current Exhibits**

February 2007

  
Ross Togashi Photo Exhibit

  
Special Collections:  
Postcard Exhibit

  
Bridge Exhibit: Paradise Lost and  
Saved



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# Link Tag

- Link
  - Anchor tag <a>...</a>
  - 3 kinds
    - Link to page in same folder
    - Link to page in different folder
    - Link to outside webpage on the Internet.



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# Example of Anchor Tag

```
<a href="http://www.iitkgp.ac.in">Go to the IITKgp home page</a>
```

address

text in page

- Two components
  - Address
  - Text or description – this is what you see on the page

# Image Source Tag

- Empty tag – no closing tag
- Components of Img tag

```

```

- **url** = points to location of the image file
- **alt** = describes image for screen readers



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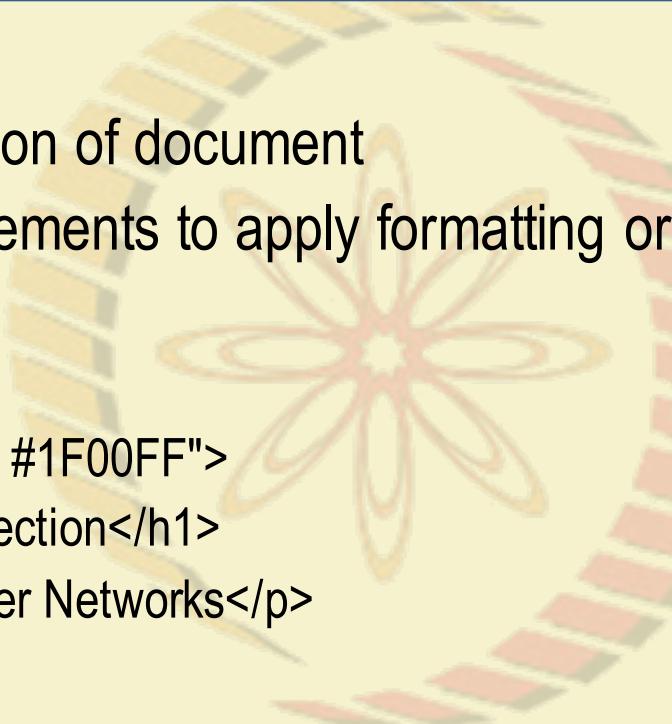
# File location

- Same folder: “samplePic.gif”
  - Document-relative link
  - Look for image in same folder
- Different folder named images: “/images/samplePic.gif”

# Division Tag

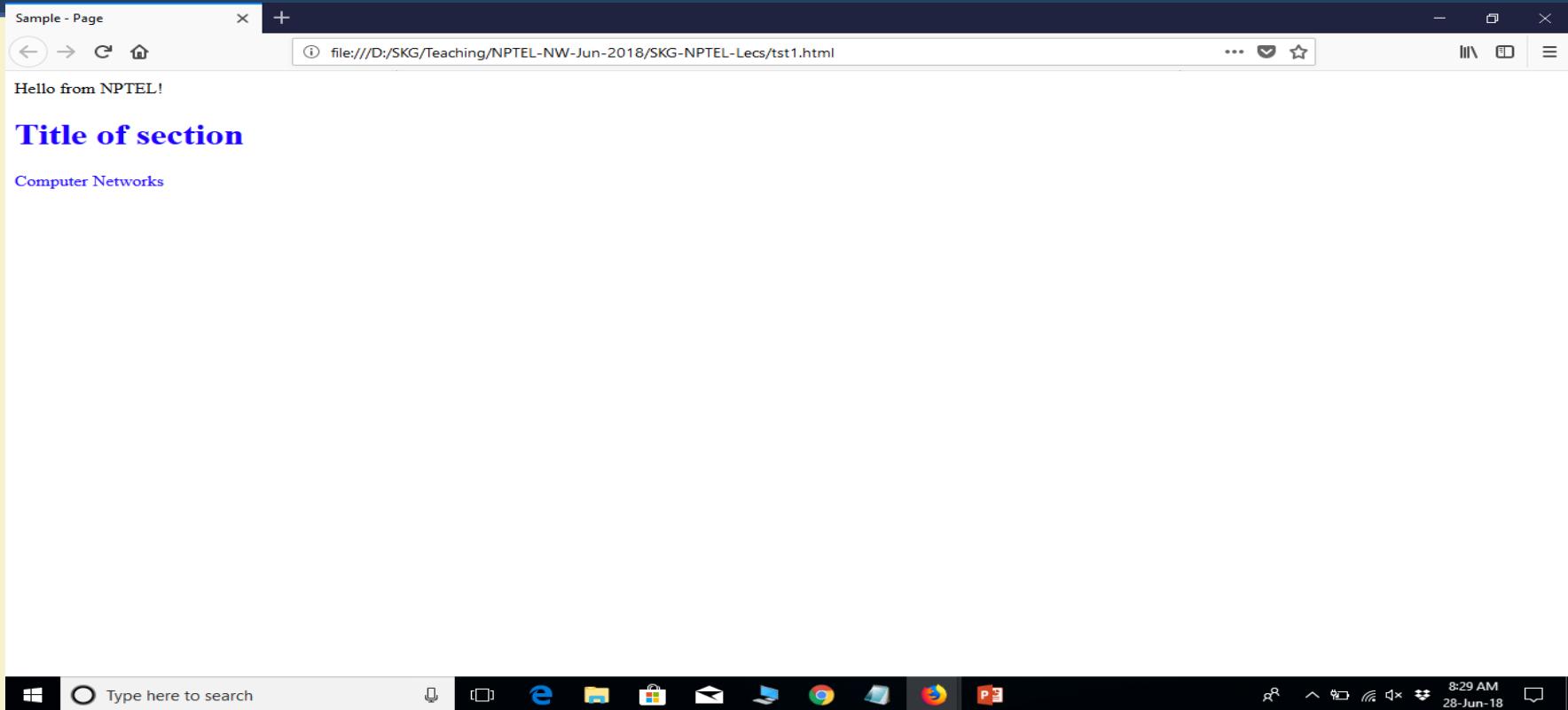
- <div>...</div>
  - Division or section of document
  - Use to group elements to apply formatting or style
  - Example:

```
<div style="color: #1F00FF">
  <h1> Title of section</h1>
  <p> Computer Networks</p>
</div>
```



```
<html>
<head>
<title> Sample - Page</title>
</head>
<body>
Hello from NPTEL!
<div style="color: #1F00FF">
  <h1> Title of section</h1>
  <p> Computer Networks </p>
</div>

</body>
</html>
```



# Examples of use of Links

The screenshot shows a library website with a header navigation bar: Home | Research Tools | Personal Services | About the Library. Below the header is a large photograph of a library interior with people at desks. The page is divided into several sections:

- Ask Us** (highlighted with a red circle): Includes a Site Search input field and a "Site Search" button.
- Quick Links**:
  - Hours
  - Staff Directory
  - Departments
  - UH Libraries
  - Other Libraries
  - Work @ the Library
  - Donations
  - FAQ
- News & Events**:
  - Touring Paradise: War & South Pacific
  - Karen Peacock PIALA award
  - Faculty Lecture Series
  - Workshops That Matter
- Find Books & Media** (highlighted with a pink circle):
  - Search or [Basic Search] input fields
  - Research Tools**:
    - UH Catalog (Find Books & Media)
    - E-Resources & Databases
    - Electronic Journals
    - Browse by Subject
    - Quick Facts
    - Digital Collections
    - More Tools...
  - About the Library**:
    - Hours
    - Directions
    - Maps (Floorplans)
    - Study Rooms
    - Staff Directory
    - Departments
    - Computing
    - Library Calculator
    - Library Exhibits
    - More About the Library...
- Featured Resources** (highlighted with a blue circle):
  - Choose one dropdown menu
  - Go button
  - Personal Services**:
    - Your Account/Renew Books
    - Course Reserves
    - Accessibility
    - Purchase Suggestions
    - Loans from Other Libraries
    - LILO
    - Instruction
    - More Services...
  - New @Your Library**:



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# Typical HTML document

```
<html>  
  <head>  
    <title> ...document title... </title>  
  </head>  
  <body>  
    ...your page content...  
  </body>  
</html>
```



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# End Product

- <html>
- <head>
- <title>Author's Page</title>
- </head>
- <body>
- <div>
- <a href="index.html">Home</a><br />
- <a href="courses.html">Courses</a><br />
- <a href="personal.html">Personal</a><br />
- </div>
- <p>Hello my name is XYZ and I am writing about myself. Contact info:
- <a href="http://www.hawaii.edu/slis/webteam">Web Team</a>
- <div>
- 
- </div>
- </div>
- </body>
- </html>



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# Next Mission

- Choose colors for your page
  - Text color
  - Link color
  - Background color
- Choose font size
  - Type of font
  - Font size



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# TELNET

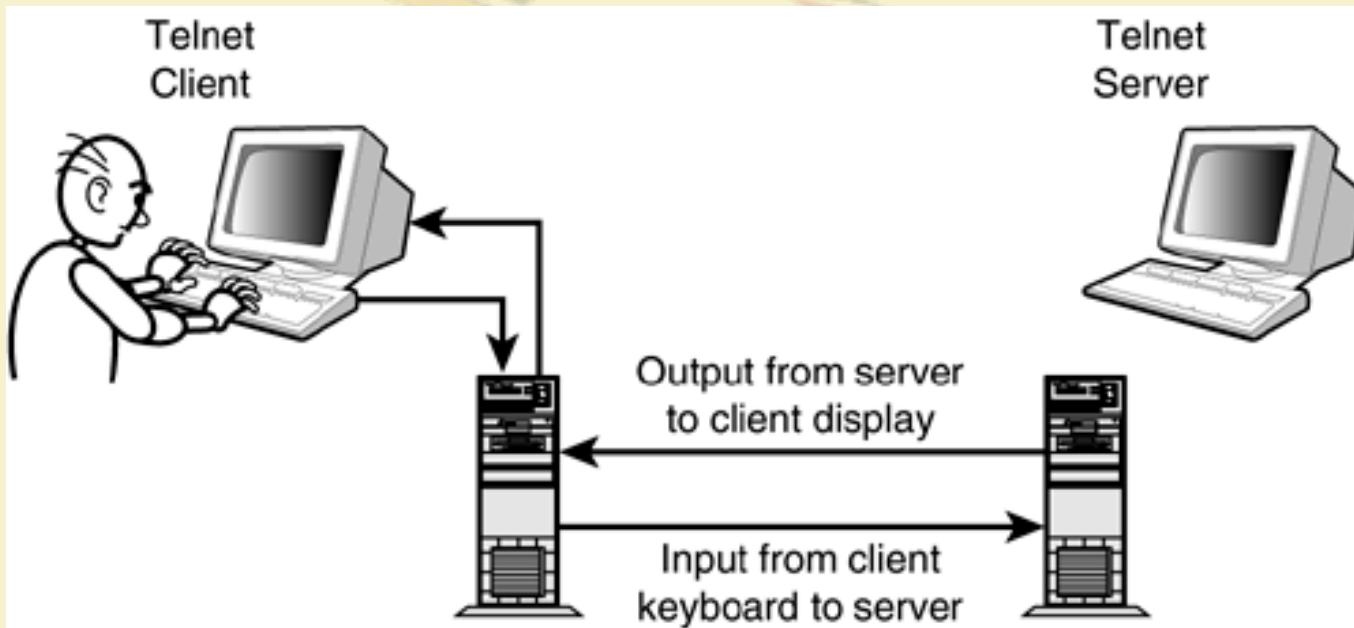


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# TELNET



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# TELNET vs. telnet

- TELNET is a *protocol* that provides “a general, bi-directional, eight-bit byte oriented communications facility”.
- **telnet** is a *program* that supports the TELNET protocol over TCP.
- Many application protocols are built upon the TELNET protocol.



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# The TELNET Protocol

❑ Reference: RFC 854

- TCP connection (Popular port: 23)
- Data and control over the same connection.
- Network Virtual Terminal
  - intermediate representation of a generic terminal.
  - provides a standard language for communication of terminal control functions.

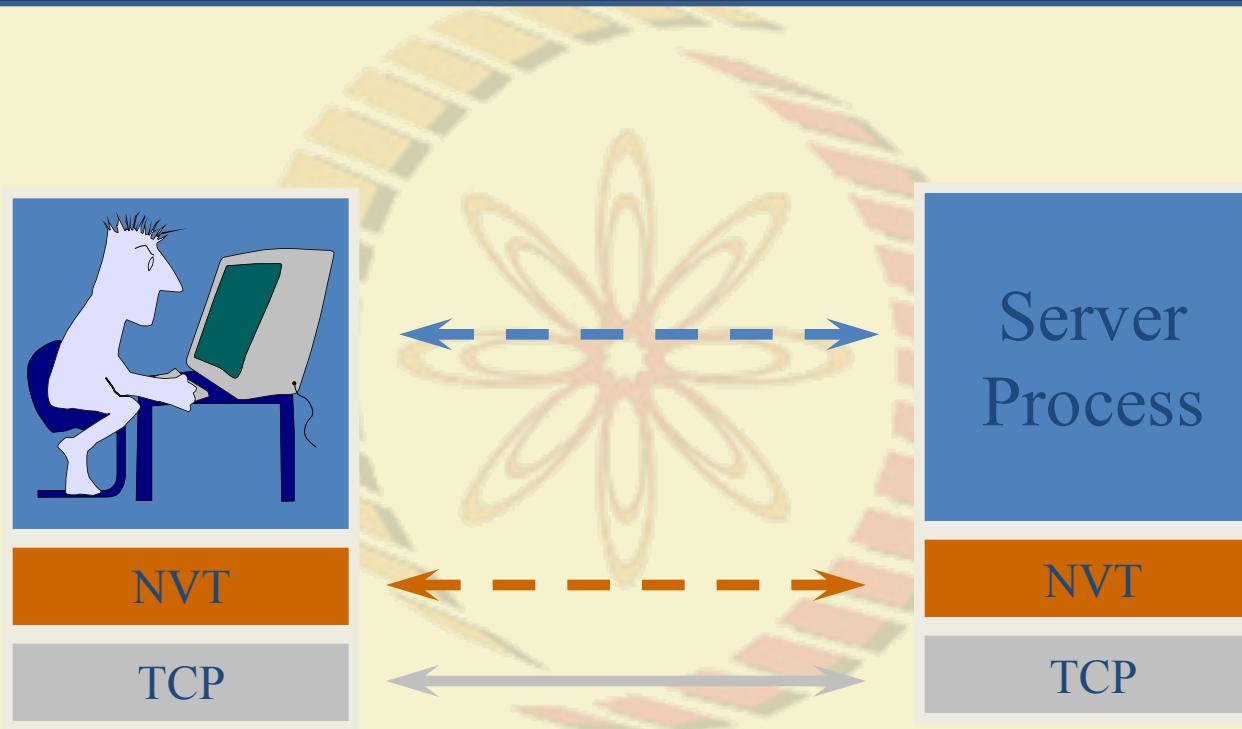


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# Network Virtual Terminal (NVT)

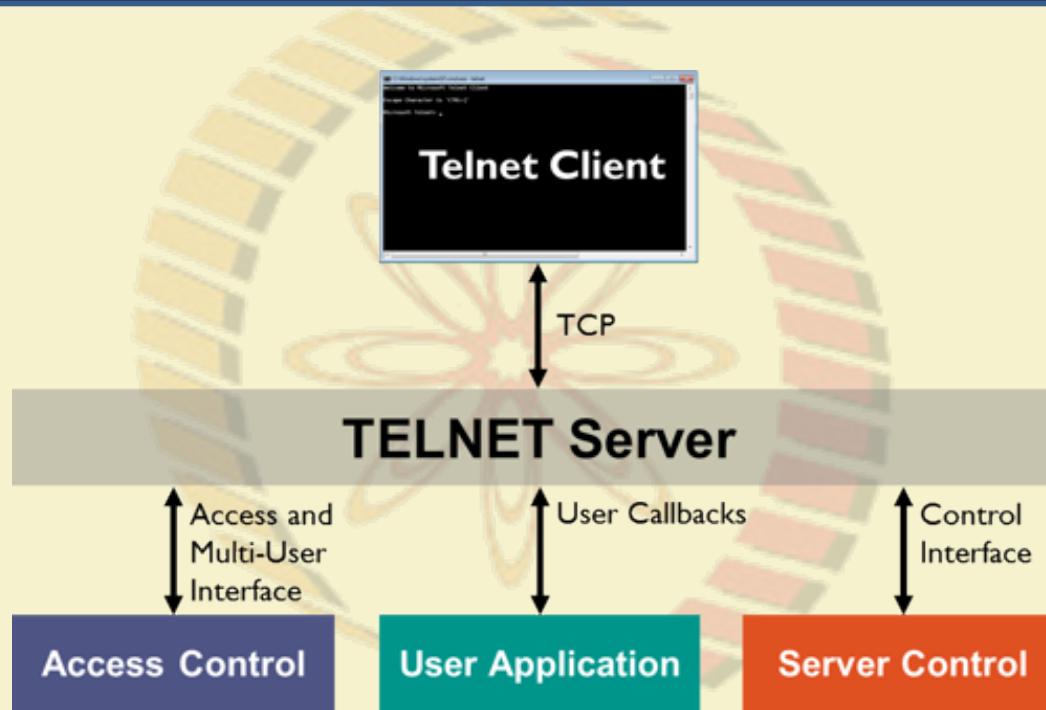


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# TELNET



# Negotiated Options

- All NVTs support a minimal set of capabilities.
  - Some terminals have more capabilities than the minimal set.
- The set of options is not part of the TELNET protocol,
  - so that new terminal features can be incorporated without changing the TELNET protocol.
- Two endpoints negotiate a set of mutually acceptable options
  - Line mode vs. character mode
  - echo modes
  - character set (EBCDIC vs. ASCII)



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# Control Functions

- TELNET includes support for a series of control functions commonly supported by servers.
- This provides a uniform mechanism for communication of (the supported) control functions.



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# Control Functions

- Interrupt Process (IP)
  - suspend/abort process.
- Abort Output (AO)
  - send no more output to user's terminal.
- Are You There (AYT)
  - check to see if system is still running.
- Erase Character (EC)
  - delete last character sent
- Erase Line (EL)
  - delete all input in current line.



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# Command Structure

- All TELNET commands and data flow through the same TCP connection.
- Commands start with a special character called the Interpret as Command escape character
  - The IAC code is 255.
  - If a 255 is sent as data - it must be followed by another 255.
- If IAC is found and the next byte is IAC
  - a single byte is presented to application/terminal
- If IAC is followed by any other code
  - the TELNET layer interprets this as a command.



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# TELNET Operations

- You can use the **telnet** program to play with the TELNET protocol.
- **telnet** is a *generic* TCP client.
  - Sends whatever you type to the TCP socket.
  - Prints whatever comes back through the TCP socket
  - Useful for testing TCP servers (ASCII based protocols).
- Many Unix systems have these servers running (by default):
  - **echo**                  port 7    **discard**                  port 9
  - **daytime**                port 13    **chargen**                port 19



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# telnet hostname port

```
> telnet skg.cse.edu 7
Trying 234.197.140.246...
Connected to skg.cse.edu
(234.197.140.246).
Escape character is '^]'.
Hi SKG
Hi SKG
Testing telnet
Testing telnet
^]
telnet> quit
Connection closed.
```

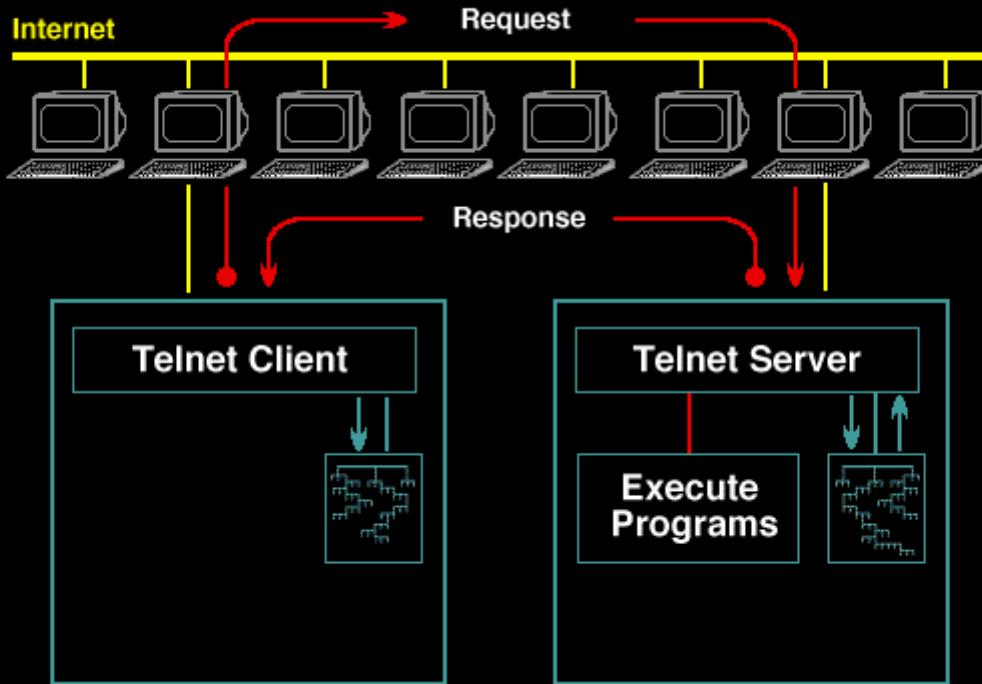


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# TELNET



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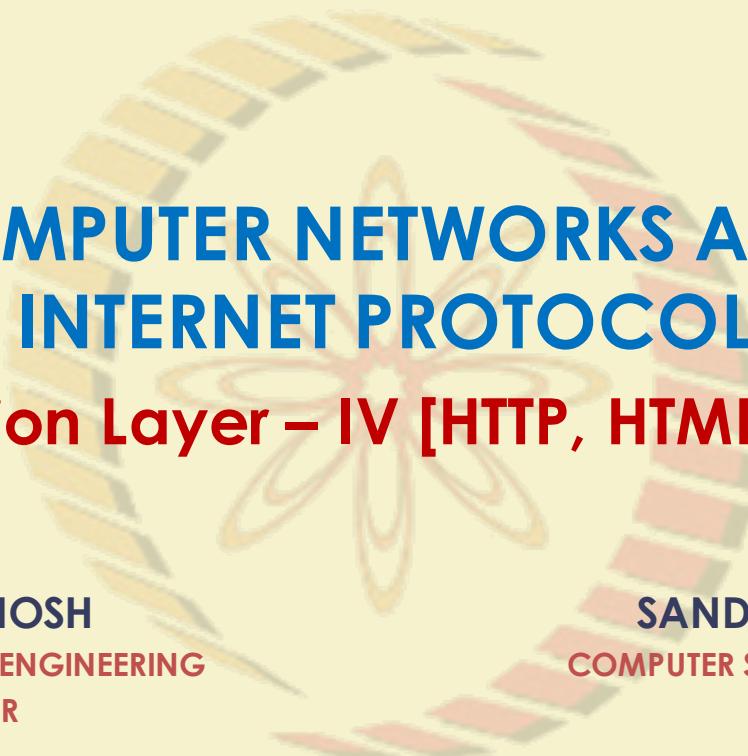
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# **COMPUTER NETWORKS AND INTERNET PROTOCOLS**

## **Application Layer – IV [HTTP, HTML, TELNET]**

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# Simple Mail Transfer Protocol (SMTP)



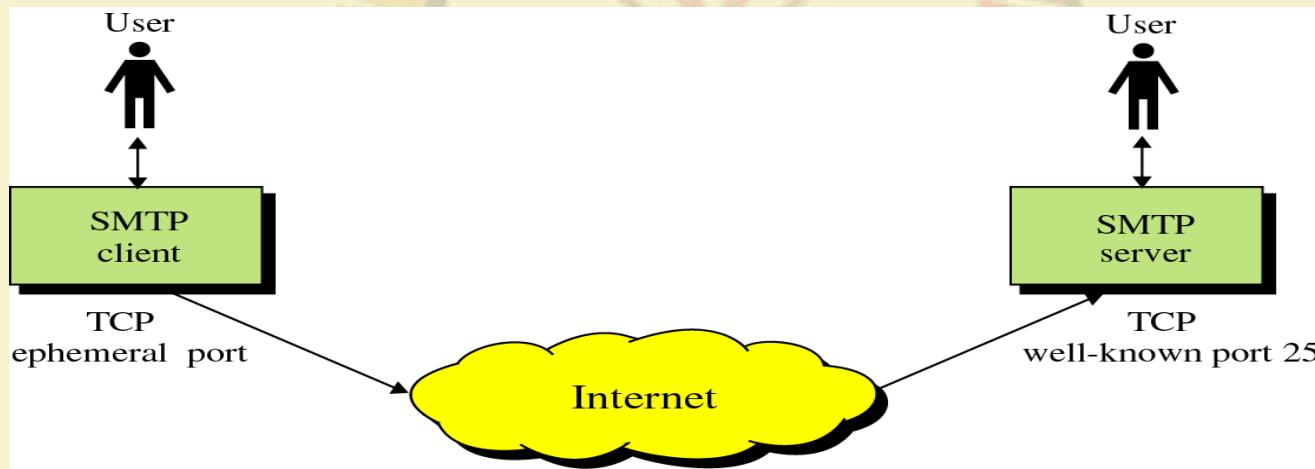
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# SMTP

- Protocol originated in 1982 (RFC821, Jon Postel)
- Standard message format (RFC822,2822, D. Crocker)
- Goal: To transfer mail reliably and efficiently



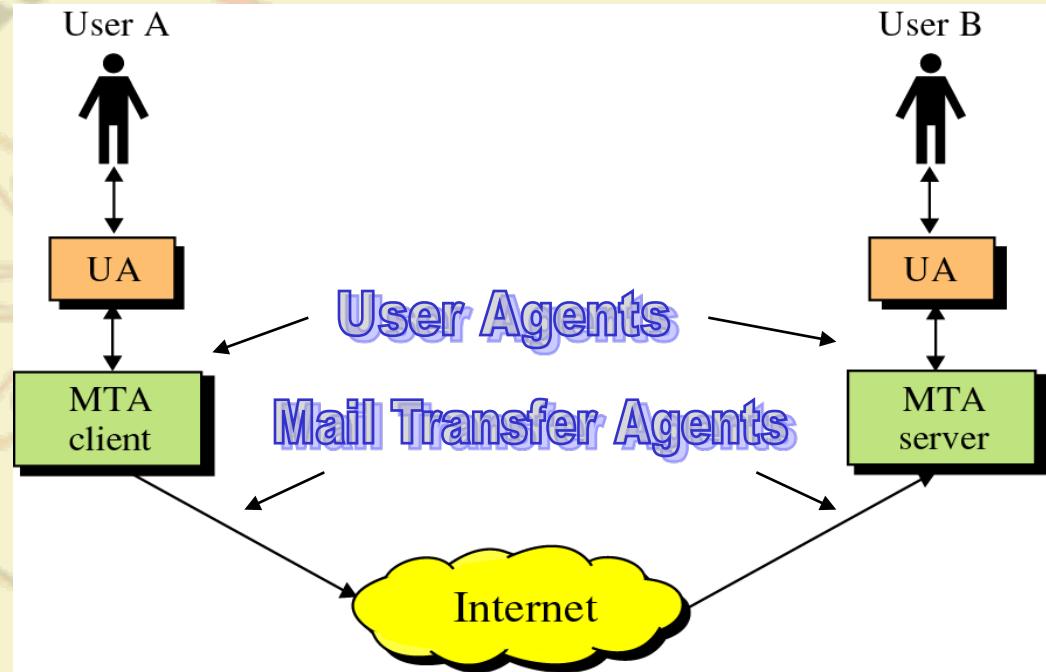
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# SMTP

- SMTP clients and servers have two main components
  - User Agents – Prepares the message, encloses it in an envelope. (ex. Thunderbird, Eudora)
  - Mail Transfer Agent – Transfers the mail across the internet (ex. Sendmail, Exim)
  - Analogous to the postal system in many ways



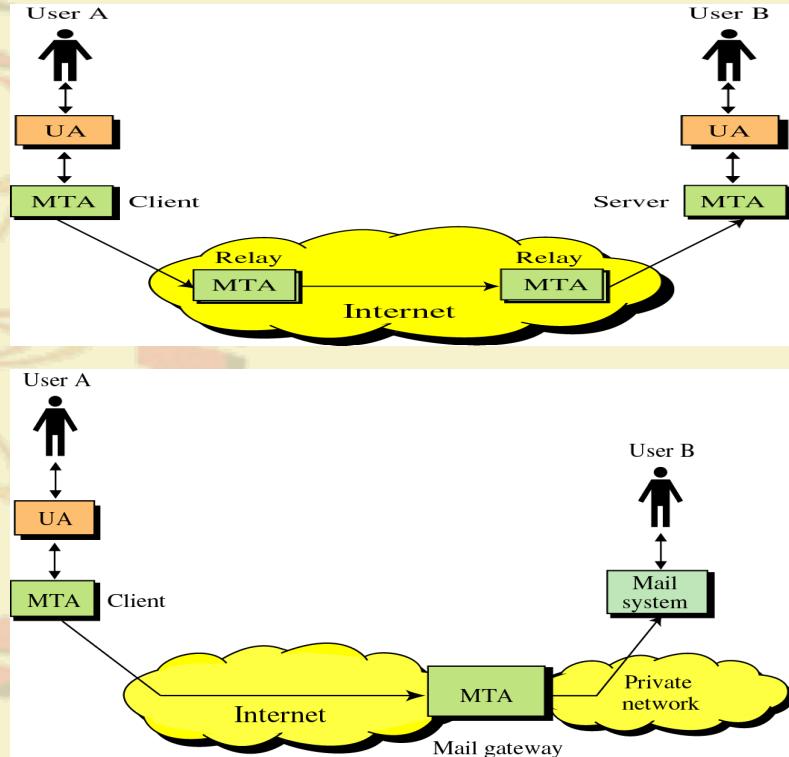
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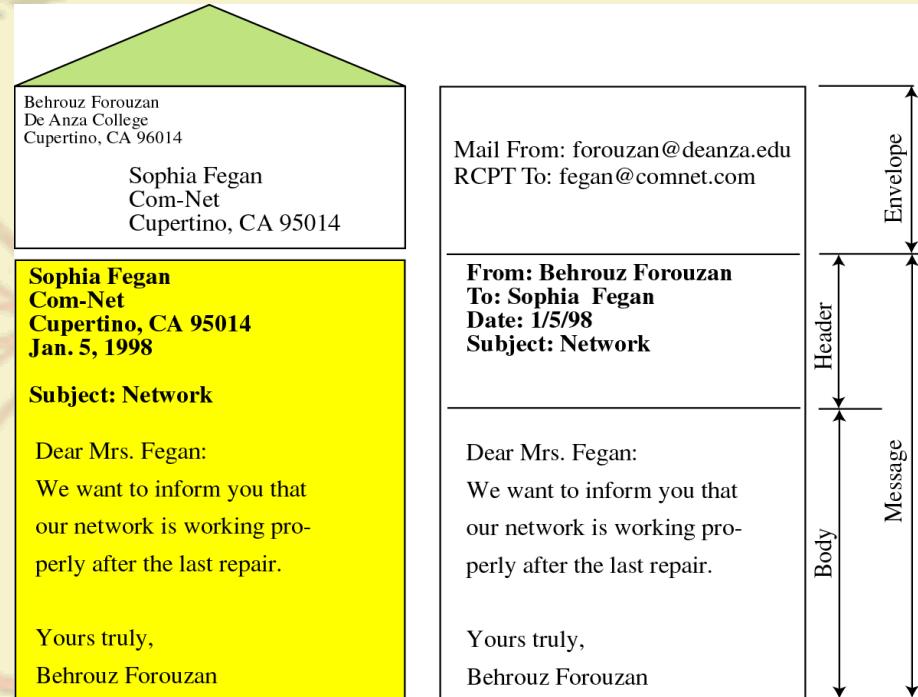
# SMTP

- SMTP also allows the use of Relays allowing other MTAs to relay the mail
- Mail Gateways are used to relay mail prepared by a protocol other than SMTP and convert it to SMTP



# Typical form of an Email

- Mail is a text file
- Envelope –
  - sender address
  - receiver address
  - other information
- Message –
  - Mail Header – defines the sender, the receiver, the subject of the message, and other information
  - Mail Body – Contains the actual information in the message



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# SMTP Keywords

Keyword	Arguments
HELO	Sender's Host Domain Name
MAIL FROM:	Email Address of sender
RCPT TO:	Email of Intended recipient
DATA	Body of the message
QUIT	



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# SMTP Keywords

Keyword	Arguments
RSET	
VRFY	Name to be verified
NOOP	
TURN	
EXPN	Mailing list to expand
HELP	Command Name



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# Status Codes

- The Server responds with a 3 digit code that may be followed by text info
  - 2## - Success
  - 3## - Command can be accepted with more information
  - 4## - Command was rejected, but error condition is temporary
  - 5## - Command rejected, Bad User!

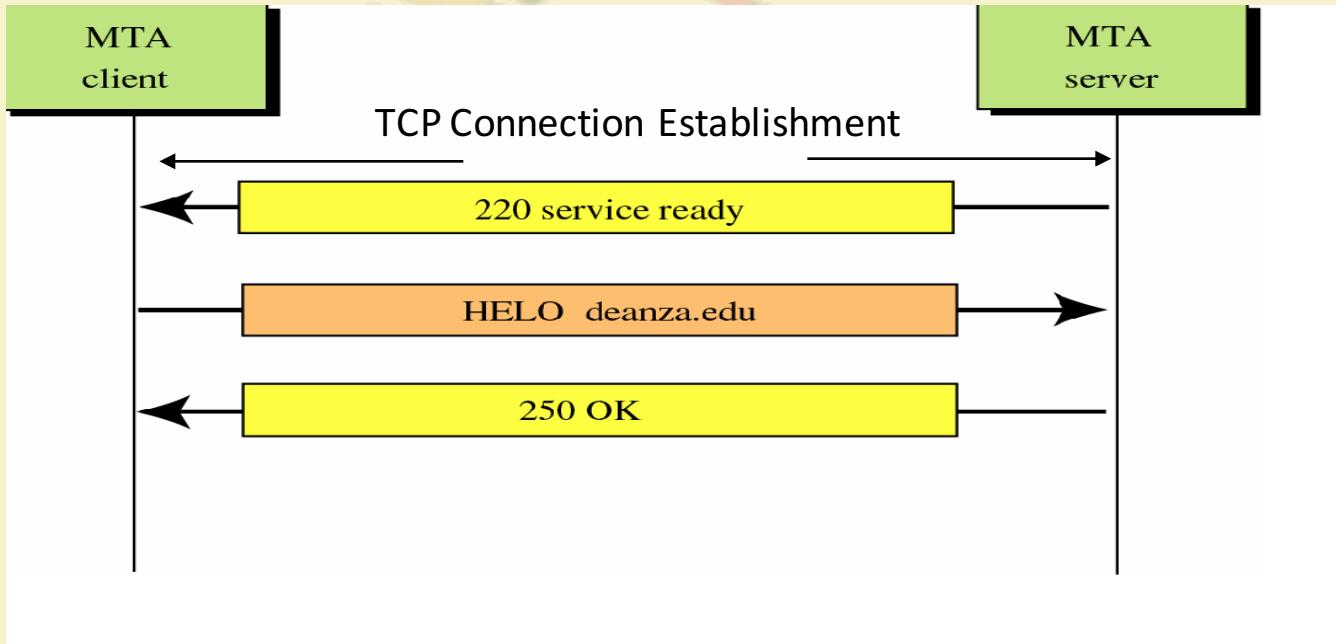


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# Connection Establishment

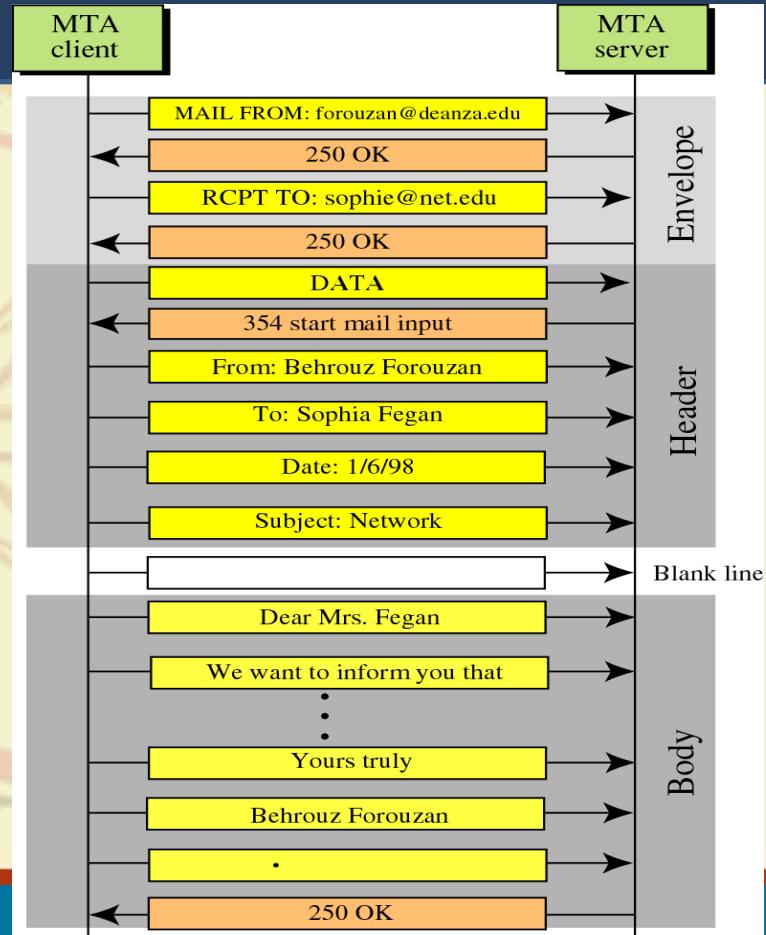


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# Message Progress

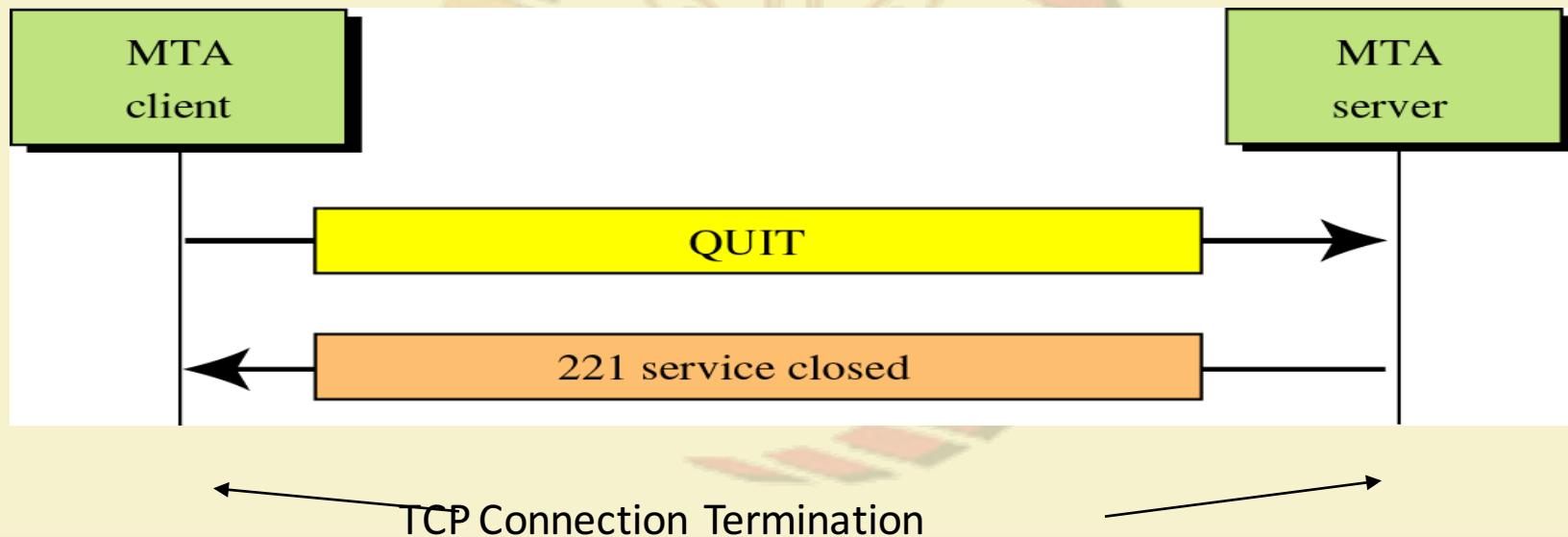


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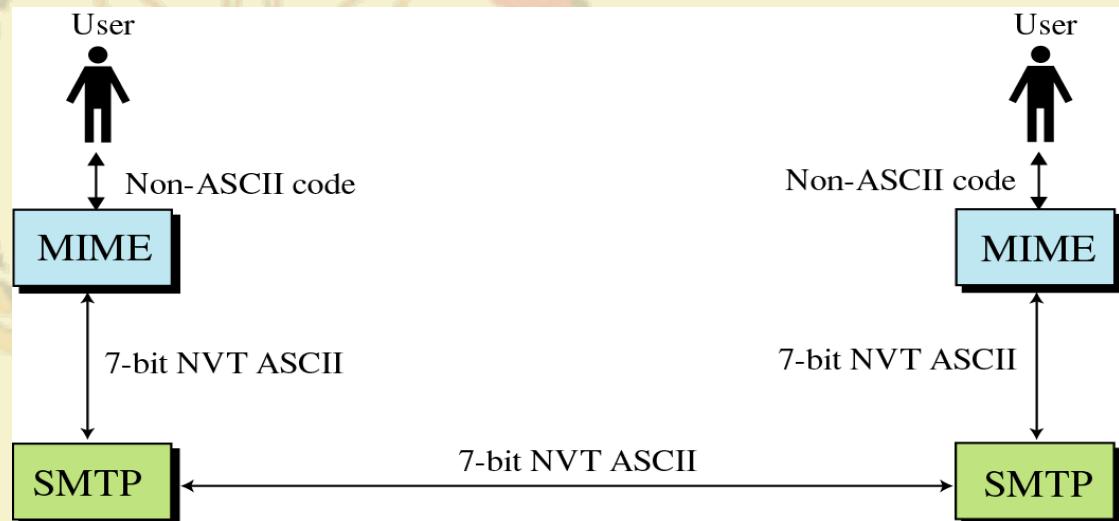
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# Connection Termination



# Solution: SMTP extensions

- MIME – Multipurpose Internet Mail Extensions
  - Transforms non-ASCII data to NVT (Network Virtual Terminal) ASCII data
    - Text
    - Application
    - Image
    - Audio
    - Video



# MIME Headers

- Located between the Email Header and Body
  - MIME-Version: 1.1
  - Content-Type: type/subtype
  - Content-Transfer-Encoding: encoding type
  - Content-Id: message id
  - Content-Description: textual explanation of non-textual contents



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# MIME Headers (cont'd)

- Content-Type – Type of data used in the Body
  - Text: plain, unformatted text; HTML
  - Multipart: Body contains different data types
  - Message: Body contains a whole, part, or pointer to a message
  - Image: Message contains a static image (JPEG, GIF)
  - Video: Message contains an animated image (MPEG)
  - Audio: Message contains a basic sound sample (8kHz)
  - Application: Message is of data type not previously defined
- Content-Transfer-Encoding – How to encode the message
  - 7 bit – no encoding needed
  - 8 bit – Non-ASCII, short lines
  - Binary – Non-ASCII, unlimited length lines
  - Base64 – 6 bit blocks encoded into 8-bit ASCII
  - Quoted-printable – send non-ASCII characters as 3 ASCII characters, =##, ## is the hex representation of the byte



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# MTAs and Mail Access Protocols

- The MTA delivers email to the user's mailbox
  - Can be complex with numerous delivery methods, routers, and ACLs
  - Exim, Postfix, Sendmail
- 
- The Mail Access Protocols are used by the users to retrieve the email from the mailbox
    - POP3
    - IMAP4



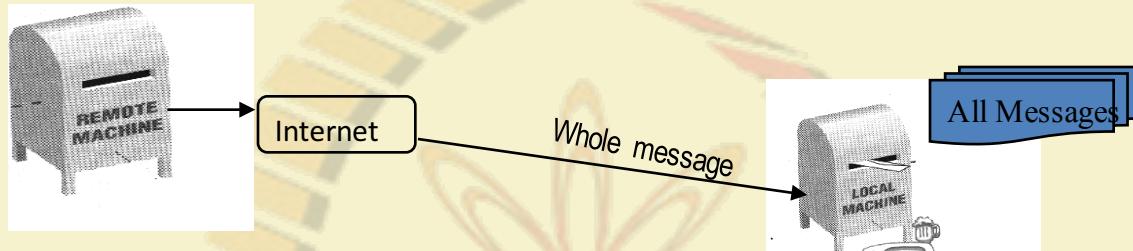
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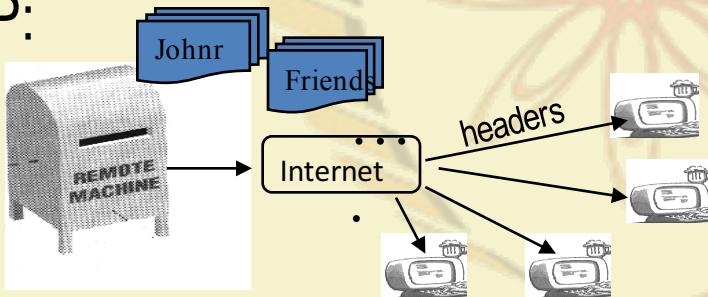
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# POP vs. IMAP

POP3:



IMAP:



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# Post Office Protocol v3

- Simple
- Allows the user to obtain a list of their Emails
- Users can retrieve their emails
- Users can either delete or keep the email on their system
- Minimizes server resources



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# Internet Mail Access Protocol (IMAP) v4

- Has more features than POP3
- User can check the email header before downloading
- Emails can be accessed from any location
- Can search the email for a specific string of characters before downloading
- User can download parts of an email
- User can create, delete, or rename mailboxes on a server



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# **Simple Network Management Protocol (SNMP)**



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# Network Management

The development of SNMP was to be kept simple, facilitating rapid deployment of the protocol throughout the Internet community. After the immediate management needs were met, albeit temporarily, by SNMP, thorough research and development could be performed on CMIS/CMIP. Ultimately, this protocol would then be deployed as a permanent solution, replacing SNMP.



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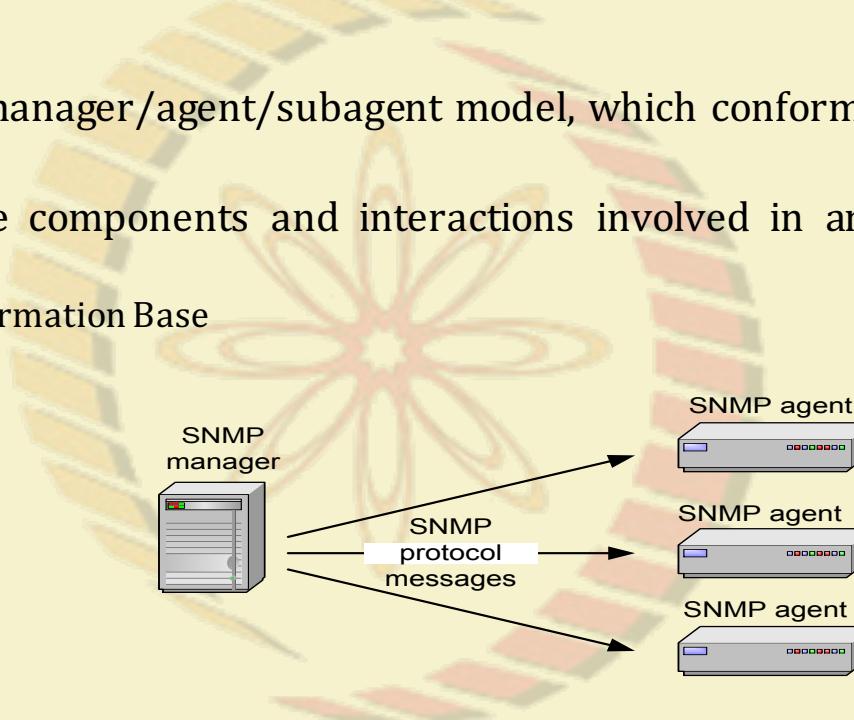
# Simple Network Management Protocol (SNMP)

Fundamental objective of Simple Network Management Protocol (SNMP) is to manage all aspects of a network, as well as applications related to that network.

- **Monitor:** SNMP implementations allow network administrators to monitor their networks in order to--among other things--ensure the health of the network, forecast usage and capacity, and in problem determination.
- **Manage:** SNMP provides the capability for network administrators to affect aspects with the network. Values which regulate network operation can be altered, allowing administrators to quickly respond to network problems, dynamically implement new network changes, and to perform real-time testing on how changes may affect their network.

# Simple Network Management Protocol (SNMP)

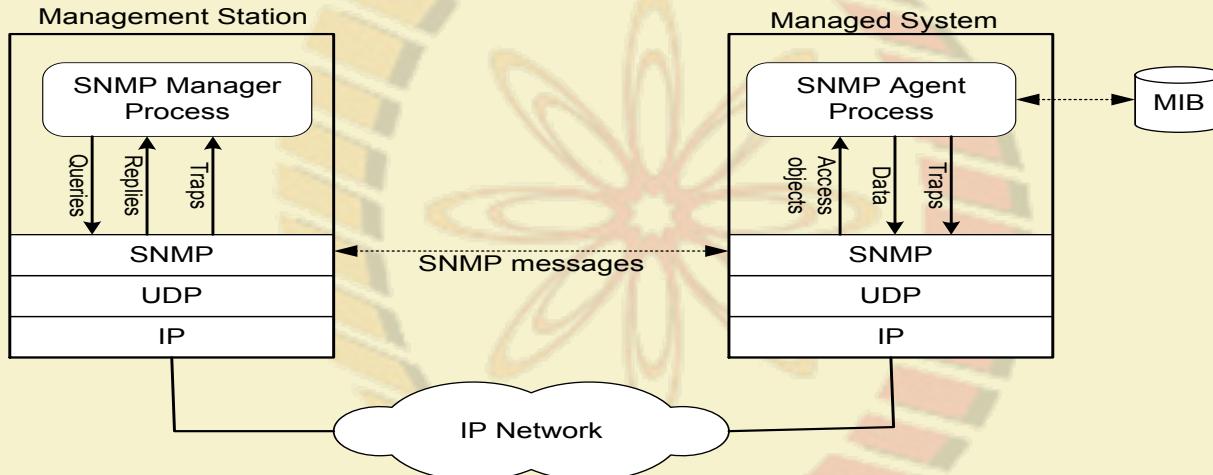
- SNMP implements a manager/agent/subagent model, which conforms very closely to the client/server model.
- RFC 1157 defines the components and interactions involved in an SNMP community, which include:
  - A Management Information Base
  - An SNMP agent
  - An manager
  - SNMP subagents



# Simple Network Management Protocol (SNMP)

- **SNMP agent** is software that runs on a piece of network equipment (host, router, printer, or others) and that maintains information about its configuration and current state in a database
- Information in the database is described by **Management Information Bases (MIBs)**
- An **SNMP manager** is an application program that contacts an SNMP agent to query or modify the database at the agent.
- **SNMP protocol** is the application layer protocol used by SNMP agents and managers to send and receive data.

# SNMP - Interactions



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# Management Information Bases (MIBs)

- A **MIB** specifies the managed objects
- **MIB** is a text file that describes managed objects using the syntax of ASN.1 (Abstract Syntax Notation 1)
- ASN.1 is a formal language for describing data and its properties
- In Linux, MIB files are in the directory */usr/share/snmp/mibs*
  - Multiple MIB files*
  - MIB-II (defined in RFC 1213) defines the managed objects of TCP/IP networks*

# Managed Objects

- Each managed object is assigned an *object identifier (OID)*
- OID is specified in a MIB file.
- An OID can be represented as a sequence of integers separated by decimal points or by a text string:
- When an SNMP manager requests an object, it sends the OID to the SNMP agent.



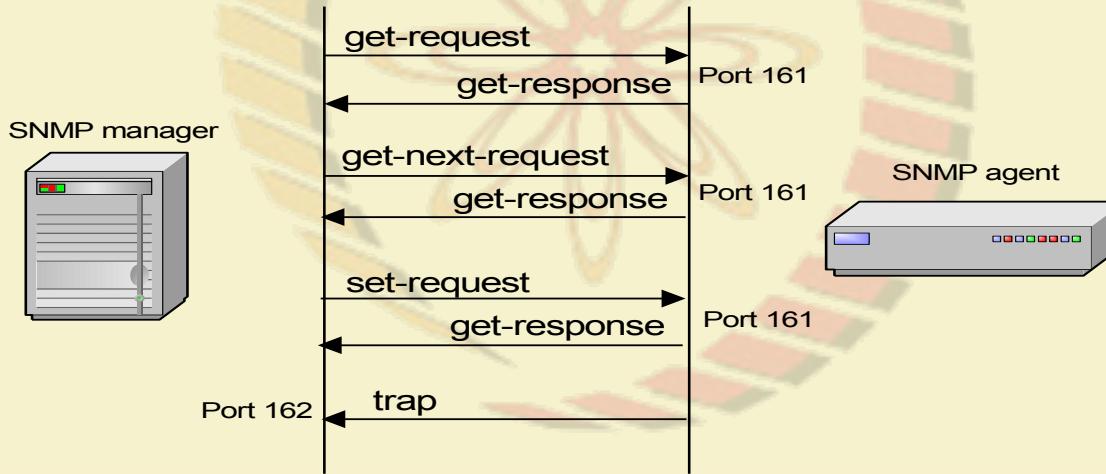
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# SNMP Protocol

- SNMP manager and an SNMP agent communicate using the SNMP protocol
  - Generally: Manager sends queries and agent responds
  - Exception: Traps are initiated by agent.



# SNMP Protocol

- **Get-request.** Requests the values of one or more objects
- **Get-next-request.** Requests the value of the next object, according to a lexicographical ordering of OIDs.
- **Set-request.** A request to modify the value of one or more objects
- **Get-response.** Sent by SNMP agent in response to a *get-request*, *get-next-request*, or *set-request* message.
- **Trap.** An SNMP trap is a notification sent by an SNMP agent to an SNMP manager, which is triggered by certain events at the agent.



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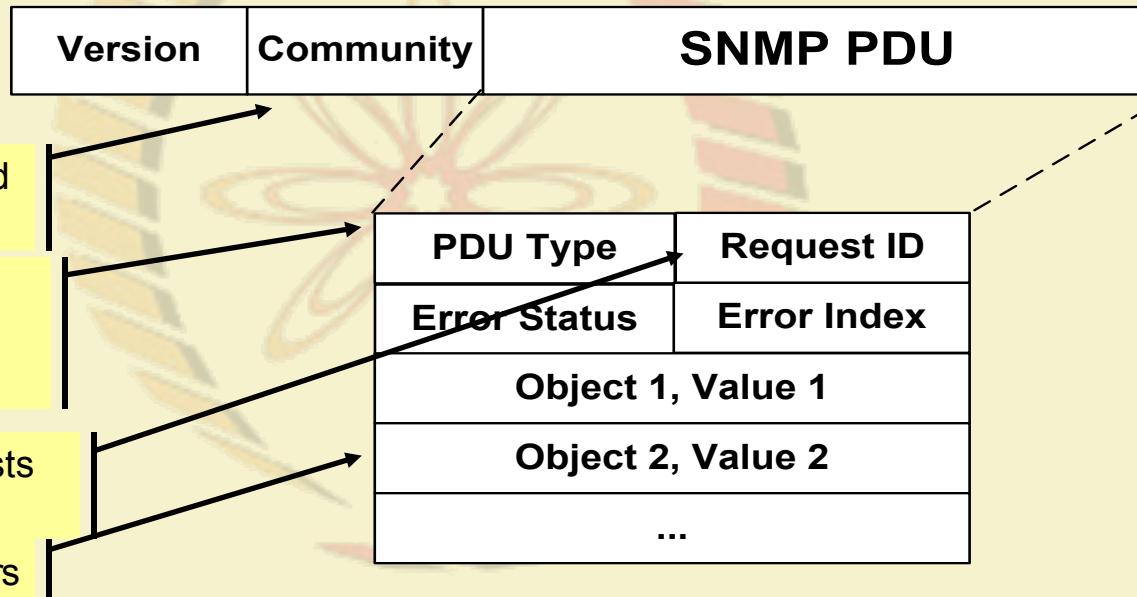
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# SNMP Versions

- Three versions are in use today:
  - SNMPv1 (1990)
    - Adds “GetBulk” function and some new types*
    - Adds RMON (remote monitoring) capability*
  - SNMPv2c (1996)
    - SNMPv3 started from SNMPv1 (and not SNMPv2c)*
    - Addresses security*
  - SNMPv3 (2002)
- All versions are active
- Many SNMP agents and managers support all three versions of the protocol.

# Format of SNMP Packets

- SNMPv1 Get/Set messages:



# SNMP Security

- SNMPv1 uses plain text community strings for authentication as plain text without encryption
- SNMPv2 was supposed to fix security problems, but effort de-railed (The “c” in SNMPv2c stands for “community”).
- SNMPv3 has numerous security features:
  - Ensure that a packet has not been tampered with (**integrity**),
  - Ensures that a message is from a valid source (**authentication**)
  - Ensures that a message cannot be read by unauthorized (**privacy**).

# References

1. “TCP/IP Tutorial and Technical Overview”, An IBM Redbooks publication, 2006.
2. Data Communications & Networking, Behrouz A. Forouzan
3. TCP/IP Protocol Suite, B. Forouzan
4. SMTP, TCP/IP and Upper Layer Protocols, Ezra Kissel, M. Lacroce and J. Watson
5. Internet resources



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